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AMERICAN EXPORT TRADE.

The figures revealed by the reports of trade for the two-thirds of the fiscal year up to the end of February, show that the excess of exports over imports continues upon the same remarkable scale that has characterized our international commerce of the past two or three years. For the eight months of 1900-1 the exports reached a total of slightly over $1,000,000,000, giving an excess over imports of $491,000,000. In the corresponding period of 1899-1900 the exports were slightly over $900,000,000, showing an excess over imports of $364,000,000. It will be admitted that these are extraordinary figures, for large as our export trade was, it again shows an increase, and disproportionate as the relation between exports and imports appears to be, it is seen that the exports are nearly one-third greater as to excess than they were in the previous period. It is hard to find fault with such figures, but at the same time it would have been more satisfactory had the increase consisted in manufactures rather than, as they do, in products of agriculture. As a matter of fact, manufactures have declined slightly from a percentage of 29.68 per cent to 27.03 per cent. Still, this might have been expected in view of the troubled relations in China, where our trade has sadly shriveled up, and also to the continued industrial weakness in such disturbed regions as South Africa, Cuba and the Philippines.

In another column this week a somewhat closer analysis will be found of the figures which relate more specifically to manufactures of iron and steel and metals in general. It is there that the statistics of electrical and mechanical export will be found, and it will be noted that the appreciation of electrical apparatus of American make throughout the world shows no signs of falling off. On the contrary, it must be said to be growing in an encouraging manner, to which perhaps the efforts of this journal and the activity manifested by progressive electrical manufacturers, are contributing in some degree. In this connection we can only repeat our regrets that owing to a dispute over the sugar tariff, this country should have got into a commercial deadlock with Russia so that the hopeful prospects of electrical exports to that great section of the globe are seriously overloaded. The increases in duty are apparently enormous, the rise being, it would seem according to the copy of the new tariff recently forwarded, from 72.01 cents per pood to $1.313 and 30 per cent, on motors, engines and dynamos. Having ourselves in this country inflicted heavy duties of corresponding amount on the poor foreigner, we begin to see how it feels when the tables are turned. In respect to this dispute, as in regard to other branches of the trade, readjustment seems to be required, and it can only be once more pointed out that the most prosperous trade is that which rests on the broadest reciprocal basis.

THE EDISON STORAGE BATTERY.

In view of the deep effect that previous inventions and improvements made by Mr. Edison have had on the arts, the excitement aroused by the report that he is about to launch a new storage battery of lesser weight for equipment work and of minimized depreciation, is quite justified. We are glad, therefore, to be able to present our readers with an account that they are likely to find very interesting, of some of his latest work in this field. The patents that Mr. Edison has taken out abroad indicate the lines along which he has

been working, in the production of a copper-cadmium cell, although it may be stated that the mere description in the patent does not wholly describe the most recent developments, Mr. Edison having been busy on improvements up to the very moment at which this note is written. It is understood that Dr. Kennelly is to give the Institute a paper on the subject, and in the meantime Mr. Edison expects to have the battery at the Institute conversazione next week. Considering the need of further modifications in the modern storage battery for purposes not yet brought within its range, it is to be devoutly hoped that Mr. Edison has now added another to his long list of triumphs, by success in a field which he himself has chosen for a long time deliberately to neglect.

The Institute Conversazione.

The plans which are now ripening fast for the conversazione of the Institute of Electrical Engineers, to be held at Columbia University on April 12, promise an affair of unusual interest and importance, as may be seen from the still incomplete list of important exhibits, given in our pages this week. Such an affair is rather novel here, but tempted by the brilliant example in this direction noted by them in England, France and elsewhere in Europe last year, the officers of the Institute believe that they can make it a grand success, stimulating alike to the science and the society. We commend the effort most heartily to the support of all the members, and advise them by active participation to make it an occasion long to be remembered for the pleasure and instruction enjoyed. Columbia itself is alone well worth the visit, with its fine electrical, mechanical and chemical laboratories and museums, while the special exhibits will represent the very last results in investigation and application.

Irrigation Pumping in California.

The use of electric transmission and distribution for supplying power to irrigating well pumps in California is believed by many acquainted with the conditions to be one of the most important of the coming electrical developments in that State. The amount of electric power so used at the present time is by no means small, yet but a meagre portion of the available territory is being supplied with power for electric irrigation. A large number of small steam and gasoline engine pumping plants are now in use and the farmers are by no means loath to part with them if cheap electric power is available. There is also considerable territory that has not been irrigated at all, but which has a good underground water supply that can be reached by wells of moderate depth. Elsewhere in this issue one of the most notable applications of this kind, that at Bakersfield, Calif., is described. In this case both the farming and pumping are under the control of large corporations, and the best opportunity has therefore been afforded for testing of different types of apparatus and reducing all to a uniform, efficient standard. In other places power has been sold by the power companies to private farmers who put in any kind of pumping apparatus they chose. In some cases inefficient machinery has been used and the bills rendered from the meter readings have been so large that the power companies are wisely beginning to consider that unless they look after the machinery their customers install there is danger that the use of electricity for irrigation will get a black eye among farmers.

The centrifugal pump for use with the electric motor has reached a high state of perfection in California, a matter which should be a source of satisfaction to electrical engineers, for no other pump adapts itself so readily to use with the electric motor. It is in its present state efficient, noiseless, requires a minimum of repairs and can be direct connected to the motor shaft. The centrifugal pump was known of old as a low-head machine, but single pumps are now made for 100 ft. lift, while quadruple pumps for 400 ft. lift are now running, the four pumps being "connected in series" in the latter case. The efficiency of a centrifugal pump of the type used at Bakersfield when placed at water level was found to be 67 per cent. This is probably as high as any type of electrically-driven pump. It has the drawback that to secure maximum efficiency it must be placed at the water level so that there is no suction lift. In some cases this would not be practicable, but the use of a vertical shaft motor and pump makes it easy at Bakersfield. Besides irrigation there is another class of pumping work toward which electric power companies are looking, and that is in reclaiming marsh land along the Sacramento River. There are many square miles of such land along the Sacramento, and it is being surrounded by dykes and pumped dry to make farm land. Electric power has not been used in this work yet, but the large transmission plants that are now within reach of it are not likely to overlook it unless a better market for their complete output be found elsewhere.

Pumping of this kind makes a very desirable load, as it is constant night and day during the irrigating season. As a consequence, the companies supplying electric power can and do make very low rates. In the neighborhood of Los Angeles, where there is the greatest amount of electric irrigation pumping, the rates are about 2 cents per kilowatt-hour. The main drawback to this work from the standpoint of the power companies is that it comes at a time of year when the water is lowest in the mountain streams and when they can get the minimum amount of power from their water-power plants.

Arc Lighting in London.

An article, which we reprinted in last week's issue, on the lighting of the Thames Embankment in London, has an interest rather from the insight which it gives of the radical difference between British and American methods in dealing with electrical development, than from bringing out any engineering details of importance. In the early history of electric lighting, the Thames Embankment figures prominently as having been the scene of the first extensive attempt at outdoor lighting, 20 Jablochkoff candles having been there installed as early as December, 1878. Eight years later the Government authorities came to the conclusion that the lighting was unsatisfactory, and gas lighting was resumed at a date when the arc light for street illumination was becoming firmly established in this country and was rapidly driving out the gas light. Though tenders for the continuation of electric lighting were applied for in 1884, nothing had been accomplished up to 1892, when another branch of the Government stepped in and took up the problem. The following year authority was obtained to erect a plant, which, however, was not finally put in operation until February of this year.

After all these years expended in considering the simple question of lighting a relatively small extent of river front, one would expect as a result the installation of a model plant in every respect. In point of fact, the plant just installed is of a type that would appear antiquated in this country. Though the enclosed arc lamp is rendering the open arc an anachronism with us, the latter is employed in the London plant. The arc machines are rope-driven, and

are only of about half the capacity of standard American arc lighters. A combination of series and parallel lighting is used, in which the intrinsic merits of either system appear to be sacrificed. Altogether the installation is of a kind that might have been made in this country fifteen or more years ago, but certainly would not be considered at the present time.

MAGNETIC DISTURBANCES ACCOMPANYING THE TOTAL SOLAR ECLIPSE OF MAY 28, 1900.

In the December, 1900 (No. 4, Vol. V.), issue of *Terrestrial Magnetism and Atmospheric Electricity*, appears an interesting paper by Mr. L. A. Bauer, in charge of the Magnetic Department, United States Coast and Geodetic Survey. It seems that in advance of last year's total eclipse, arrangements were made by the Coast Survey to observe the horizontal component of the earth's magnetism, the magnetic declination, and also the temperature of the air, at three stations distributed along the belt of totality in Alabama, North Carolina and Virginia, as well as at three stations situated at some distance from the belt of totality. The instruments employed differed at the different locations, but the general method of observing was prescribed in advance.

On plotting the observations it was observed that there was a depression in temperature at each station accompanying the eclipse, but lagging somewhat behind it in time. This local fall of air temperature was, of course, to have been expected. Accompanying the temperature variation, however, it was found that there was at each station a small magnetic disturbance occurring not at the same moment of standard time, but associated at each station with the time of maximum obscuration of the sun's disk by the moon. The duration of the magnetic disturbance was apparently about the same as that of the eclipse, or about 2½ hours. The total range of the variation in declination was about one minute of arc, and the total range of the disturbance in horizontal intensity was about the one-three-thousandth part of the whole. The analysis of the disturbance seemed to show that the disturbing causes were external and not internal to the earth's crust, or were such as might be due to magnetic forces residing in the atmosphere, and the presumption seems to be that the origin of the disturbance was owing to the abstraction of the sun's rays from the atmosphere by the moon. The effect upon the needles of the observers seems in each case to have been such as might have been produced by a long, thin, straight, weak bar-magnet approximately coincident with the axis of the moon's shadow, and moving along with that axis over the surface of the earth, the lower end of this imaginery moving magnet being a south-seeking pole, or attracting the north-seeking poles of the observer's needles. It is stated that traces of this feeble magnetic disturbance accompanying the eclipse were felt as far from the line of totality as Toronto, Canada. The observations themselves are to be published in the appendix of the forthcoming Annual Report of the Coast and Geodetic Survey for 1899-1900.

The deduction is incidentally made from the observations that in order to render apparent variations of the order here considered, the automatically photographic recording magnetometers ought to be more sensitive and register over a wider scale. If the observations here considered had been made by standard magnetometers, instead of having been made by indicating instruments of considerable sensibility and recorded by skilled observers, the results here in question would have probably escaped observation. It is to be hoped that the next total solar eclipse which makes itself visible in the United States will be followed with many more magnetic instruments and observers than that of May 28, 1900. Fortunately, such observations do not entirely depend on fine weather for their conduction. If it is really true that the solar eclipse is accompanied by a feeble local magnetic disturbance of the earth the fact is of great importance in throwing light upon the nature of the earth's magnetism. Assuming that Prof. Bauer is right in his conclusions—and they certainly seem to be supported by many individual observations—then the general conclusion is suggested that the daily variation of the earth's magnetism is due to the effect of the sun's rays upon the atmosphere. This, indeed, has been the most recently prevailing theory; in fact, if the sun's rays incident upon the northern hemisphere seem to repel the north poles of suspended needles, as in the daily variation, then a shadow cone in these rays should appear to attract the said north poles as in these observations.

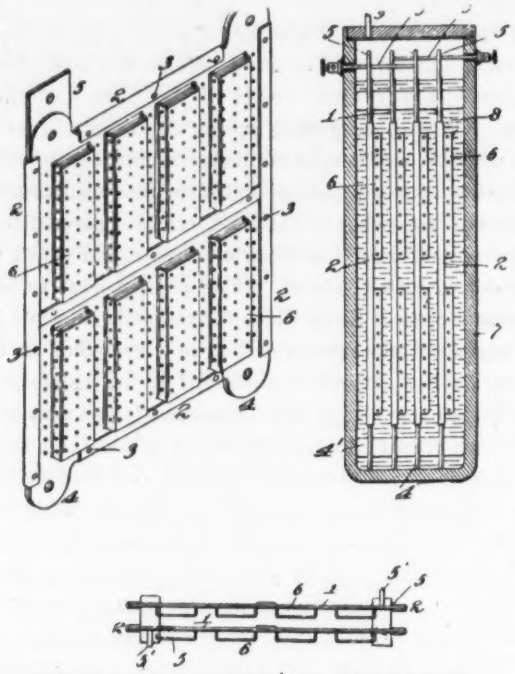
Bearing upon this general question is a paper by A. Nippoldt, in the September number of *Terrestrial Magnetism and Atmospheric Electricity*, on "The Present Status of the Theory of the Earth's Magnetism." A very interesting means due originally to Gauss is described, whereby such portion of the earth's magnetism over a given area as depends upon a potential, and upon the magnetization of the earth in the ordinary sense of the word, can be separated from whatever residuum must be due to electric currents, and which would be, therefore, devoid of a potential. If an area of country be mapped out following a contour along which the magnetic elements have been carefully observed and recorded, then in completing an imaginery circuitation, the line integral is computed of the magnetic force coincident with and around the closed contour. If this summation gives the result zero, then all of the magnetism within the contour is assignable to such causes as are accompanied by a magnetic potential; but if the summation leaves a positive or negative residuum, this indicates either an error in the process, or else a source of magnetism such as is not accompanied by a magnetic potential in the distribution, and such as a distribution of electric currents would effect. It seems that from the results of observations and calculations by this "curling" process, that the magnetic behavior of the earth is practically all attributable to a magnetic potential, if the variations or disturbances be eliminated. In other words, the permanent magnetism is such as is possessed by a permanent magnet. Superposed upon this permanent magnetism are the variations due to solar influences, and perhaps to other influences as yet untraced.

The permanent magnetism of the earth is, as we all know, far from being that of a homogeneously magnetized sphere of iron. If such a sphere were uniformly magnetized with respect to the axis of rotation, the magnetic potential at the surface should increase in proportion to the sine of the latitude; or, expressed in another way, it should increase with the distance from the earth's center of the perpendicular projection of the point of observation upon the magnetic axis. If the earth were so magnetized, the lines of equal intensity and equal dip would all be circles of latitude, and the agonic lines would all be meridians. An attempt has, however, been made to set up the hypothesis that the earth was uniformly magnetized with respect to a particular axis, and that upon this uniform magnetization there was superposed a separate distribution capable of bringing the total up to the observed distribution. Up to the present time, however, no very marked success seems to have been made in these calculations.

Edison's Work in Storage Batteries.

Considerable interest has been manifested in the announcement that Edison has been working on a new type of storage battery, but no definite information has been obtainable concerning the same. While the American patents have not yet been issued, an English patent has, however, been recently granted, an abstract of which has just appeared in a German paper. We, therefore, give below a nearly literal translation of this abstract, it being the only information which, up to the present time, is available in this country. We assume that the accumulator described therein is the one—or one among others—on which Mr. Edison is now working, as it answers to the description that it is not a lead accumulator, and that the chemical actions in it are quite different from those in the ordinary storage battery.

In some respects the German abstract is not very clear, but the general principles of the battery can be understood from the article. It seems to be fundamentally a modification of the familiar copper oxide alkaline accumulator, for which such great claims were made a dozen or more years ago, and one form of which was known in this country as the Waddell-Entz battery. One change seems to consist in having the copper more finely divided, and in the use of cadmium instead of zinc. The battery seems, apparently, to be identical with an accumulator described in a Swedish patent to Schmidt and Junger. There appears to be a misprint concerning the voltage, which is given as 44, but this is probably a misprint for 0.44, which would be a little more than a fifth of the voltage of the ordinary accumulator. This voltage corresponds approximately to that required by theory. If this is correct, it would, therefore, have to have five times the ampere-hour capacity per pound of cell to be the equivalent of the lead accumulator as to weight. Mr. Edison is understood to have said that he cuts the weight of the cell in two for equivalent work. Judging from the extract from the patent, great care is necessary to have the copper extremely finely divided, or otherwise it is claimed the copper will dissolve.



FIGS. 1, 2 AND 3.—EDISON'S STORAGE BATTERY.

The abstract, of which the following is a translation, is from the *Centralblatt fuer Accumulatoren und Elementenkunde.* The translation is as follows: The present accumulators are too heavy, because much solution is required. In this new storage battery the electrolyte remains unchanged, so that only a small quantity of it is required. As depolarizer, the lower oxide of copper is used; that is, the red oxide. In the older cells of this general type (referring presumably to the alkaline copper accumulator) soluble copper salt is said to be formed, which transfers copper to the zinc and thus produces rapid deterioration by local action. Efforts were made to prevent the circulation of this salt by surrounding the positive electrode with a porous material, but these experiments were unsuccessful because this material did not prevent the circulation entirely, and was destroyed gradually by the strong alkali; moreover, much liquid was required and the resistance of the cell was greatly increased. Edison has found that very finely divided copper forms copper oxide free from water and insoluble in alkaline lyes, whereas with the smallest particle of solid copper present or upon the pressing together of the finely divided copper, soluble hydroxide of copper is formed. Finely divided copper is artificially prepared, preferably by the reduction of the carbonate with hydrogen. As negative electrode, finely divided cadmium is used. This and the copper are in a tank of nickel or other metal, such as nickel plated iron.

Fig. 1 gives a perspective view of a plate, Fig. 2 a horizontal cross-section of a pair of plates, and Fig. 3 a vertical cross-section of a cell with two pairs of plates. The plate marked 1 is made of relatively thin sheet nickel. The lower parts of the plates are connected by insulating rods, 4, passed through the holes, 4. The pins, 5, in the holes, 5, in the upper parts of the plates are used for the electrical connection. On one side of the plates there are reservoirs or "pockets" marked, 6, for the electrode metals. These pockets are best made of perforated nickel sheets or nickel-plated sheets. The best method of cleaning the plates is to heat them in a closed compartmnt to a red heat, and then reduce the oxide by hydrogen. Cadmium in very finely divided, fibrous and very pure condition, is obtained by electrolysis of a week solution of cadmium sulphate between a thin platinum wire as cathode and a cadmium sheet as anode, using a strong current. The deposit of cadmium is removed from the cathode from time to time, and freed of the sulphate by washing with water. It is then filled into the "pockets."

Finely divided copper is obtained by the reduction of fine carbonate with hydrogen. The temperature must be kept as low as the completeness of the reduction allows, as otherwise the density of the copper is increased too much. The finely divided copper thus obtained is poured under slight pressure into thin blocks which fit the "pockets" accurately. To avoid an increase of the density of the copper in parts, the molds must not scratch or otherwise injure the plates. The plates are then heated in a closed compartment for 6 or 7 hours, to not more than 260 degs. (probably centigrade), until the copper is changed into the black cupric oxide. At higher temperatures the density is increased too much. The cupric oxide blocks are next reduced to metal electrolytically, and are then changed into the red cuprous oxide by charging. It would be possible to fill the finely divided copper first obtained, directly into the pockets; but as it is not fibrous like the cadmium, the connection between the particles is not close enough, so that it is not as good for the purpose as when treated in the way just described.

After the pockets have been filled and the plates of equal sign have been connected together, they are placed in a case, 7, which contains as electrolyte a 10 per cent solution of pure hydroxide of sodium. During the charging of the cell, cuprous oxide is formed and water is decomposed. During the discharge, cadmium oxide is formed and water is regenerated. As only a very small amount of liquid is required, it is sufficient to place thin sheets of asbestos or another light, powerful material which is not attacked by alkalies, between the plates and to moisten with the electrolyte. The internal resistance is very small. The materials are not attacked, and there is no local action between the cadmium and the nickel. The case, 7, may be made of nickel or other metal, for instance iron, the interior of which is nickel plated. The case may be sealed for liquids, the opening, 9, being required only for the gases which are formed when the cell is overcharged.

It may be added that not only has Mr. Edison stated that he would reduce the weight of the modern storage battery by one-half, but that he would reduce the depreciation to a tenth—to virtually nothing.

Automobile Show at Chicago Coliseum.

An automobile exhibition was held last week (March 23 to 30) in Chicago, as already noted, under the auspices of the *Motor Age.* The main floor of the Coliseum was well filled with the exhibits of automobile and cycle manufacturers, and a short track, gave opportunity for the exercise of vehicles. The largest electric exhibitors were the Woods Motor Vehicle Company, Chicago; Hewitt-Lindstrom Motor Company, Chicago; Electric Vehicle Company, New York; National Automobile & Electric Company, Indianapolis (Ralph Temple, Chicago, agent), and Sipe & Sigler, makers of the Willard Storage Battery Company, Cleveland. A. B. Holson, of Chicago, also had a two-wheel experimental rig and the Bachelle electric automobile was also present.

Fig. 1.—One of the Pumping Stations.

Electric Power for Irrigation Pumping at Bakersfield, California.

To many perhaps the most interesting electrical installation in the State of California is the one at Bakersfield for irrigation pumping because it is believed that this plant is the forerunner of a very great development along that line in California and elsewhere. Indeed, the Bakersfield plant, though the pioneer in its field, is not now alone, for other electric power companies in the State have followed its example in a limited way. The Bakersfield installation, however, is of the most interest, because the details have been more systematically and thoroughly worked out than in any other plant.

Bakersfield is located in the valley of the Kern River in Southern California. The climate is too dry to make farming practicable without irrigation. A great portion of the year there is no surface water flowing in the Kern River or its branches, as it is all taken off for irrigation soon after it comes down out of the mountains. This leaves the most of the valley without any water except what can be pumped. The valley is very broad and level, with mountain ranges on each side. The soil is fertile and only needs water to make it productive. It was found that while there was no water on the surface in the Kern River Valley there was a plentiful underground current which could be reached by wells 60 ft. deep. This is a condition that also prevails in many other places in California. By sinking wells so as to tap this underground flow a considerable area of country can be irrigated. The only problem is a cheap method of pumping. It is here that electric transmission and distribution steps in. At Bakersfield a company known as the Kern County Land Company owns a very large tract of land in the vicinity. The Power Development Company, of Bakersfield, of which C. N. Beal is secretary and the active spirit, and F. T. Whorff, superintendent, was organized by interests friendly to the land company for the purpose of developing the water-power of the Kern River in the mountains and transmitting it over the valley for pumping purposes and for light and power in Bakersfield. The Power Development Company sells power to the Kern County Land Company for pumping for irrigation.

The water-power plant in the cañon of the Kern River is 13 miles from the sub-station in Bakersfield. It has at present writing two 450-kw, three-phase, 500-volt, 60-cycle General Electric generators. One more unit is being put in. These are direct connected to Knight waterwheels, operating under a 200-ft. head. The efficiency of these wheels, as shown by a very careful set of weir measurements made by the company before the wheels were accepted, showed their efficiency to be 77.6 per cent at full load. While this is lower than waterwheel efficiency is generally supposed to be, it is well to mention in this connection that this figure is above the specifications drawn up by the company and that some impulse wheels previously installed failed to come up to the specifications. The governors on these waterwheels are the design of C. N. Beal, the secretary, and work on a new principle. Their working depends not only on the speed, but also on the load. That is, there is a dynamometer on the shaft between the water wheel and the generator. As the load comes on and the pull on the dynamometer increases the governor acts to turn on the water, thereby anticipating the decrease in speed which would follow the increase in load before an ordinary governor would act. In addition to the dynamometer feature of the governor there is also the usual method of governing dependent on the speed.

A new tunnel has just been finished to replace an old pipe line. With the completion of this tunnel there will be no more trouble from falling rocks, a common form of interruption with many water power plants. This tunnel is 8425 ft. long. It is smooth cement finish on bottom and sides, and has a capacity of 300 cubic feet of water per second, with a height of 5 ft. of water in the flume. Figs. 5, 6, 7 and 8 show the details of the concrete work. Fig. 10 shows the details of the sand-settling box at the end of the tunnel.

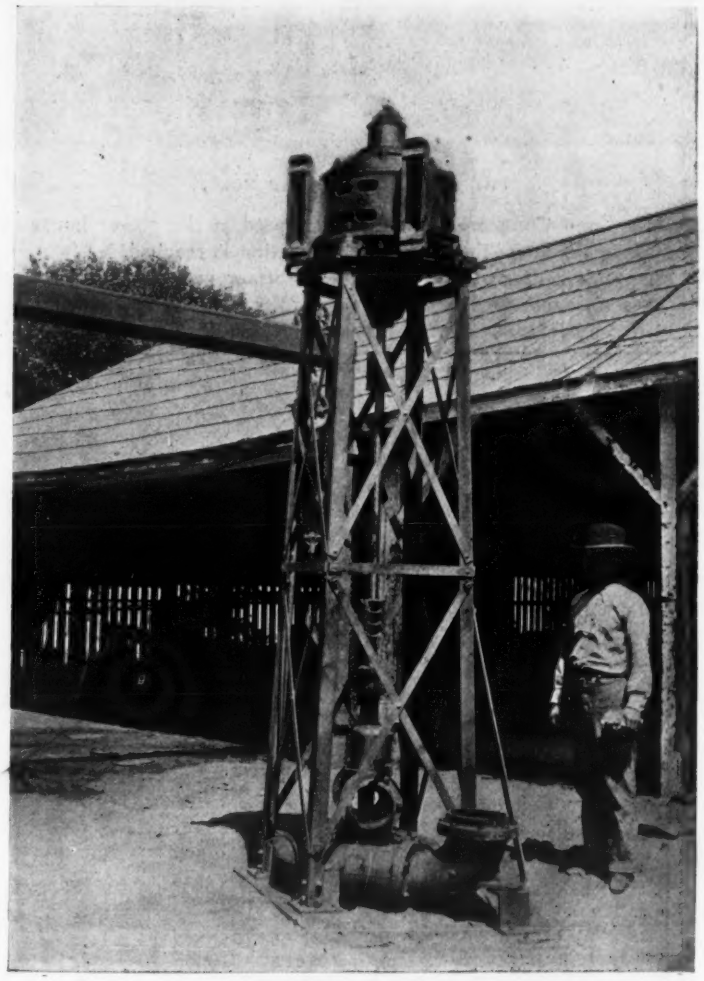


FIG. 2.—MOTOR AND PUMP BEFORE INSTALLATION.

The power is all transmitted over two three-phase lines at 10,000 volts to the sub-station in Bakersfield, where part of it is transformed down for local lighting distribution in Bakersfield, and the rest is sent on at the original voltage for the use of the Kern

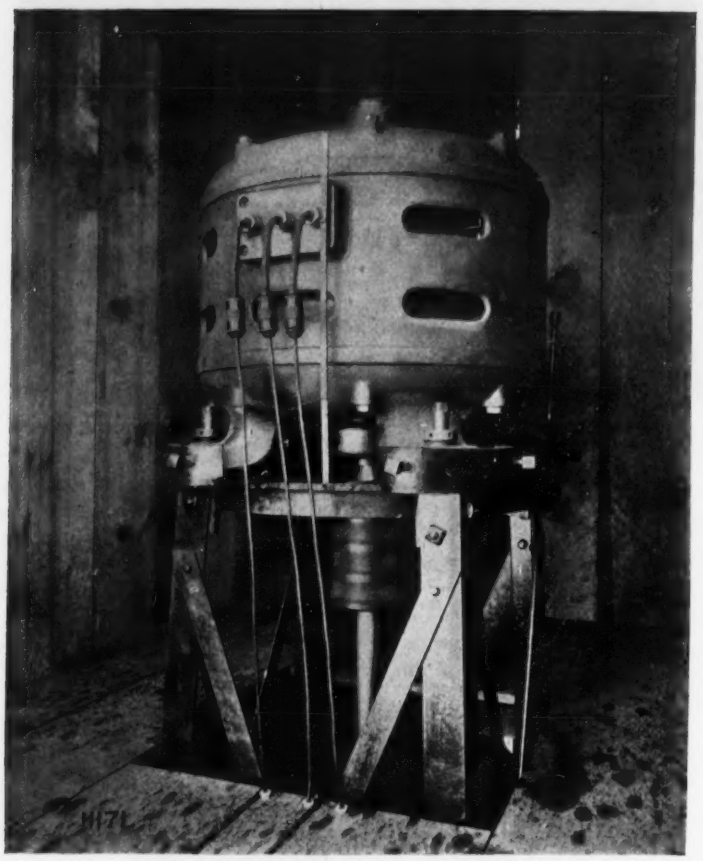


FIG. 3.—MOTOR IN PUMP HOUSE.

County Land Company. No fuses are used at the power house or anywhere along the line until the sub-station is reached.

Fig. 11 is a diagram of a new transformer panel recently put in for the alternating-current side of a rotary converter, which runs a new electric road operating between Kern City and Bakersfield. Fig. 12 shows the construction of a generator panel now being installed. Fig. 9 is the main switchboard panel at the power house.

In addition to the local lighting and railway load the Power Development Company supplies current for pumping city water. This is done with centrifugal pumps, which pump directly from wells into the mains at 35 lbs. pressure, and lift water about 12 ft. with the suction. This kind of service is an eye opener to those not familiar with the development of the centrifugal pump. There are four pumping stations of this kind for city water at the present time, and two more are to be put in.

THE PUMPING AND IRRIGATION SYSTEM.

The transmission lines and pumping stations of the Kern County Land Company, to which the Power Development Company supplies power, are shown by the map (Fig. 4). These pumping stations are under the charge of A. J. Bowie, engineer of that department of the work. The transmission lines are only shown from the sub-station at Bakersfield, where the Land Company's jurisdiction begins. From the power house to the Bakersfield sub-station, 13 miles, the lines belong to the Power Development Company. The distribution for pumping is all at 10,000 volts. The numbered stations are the standard type of pumping station such as is described and illustrated hereafter. The others are some special applications as explained on the map. The regular type of irrigation pumping station consists of two step-down transformers, usually 15 kilowatts, reducing from 10,000 to 500 volts, an outdoor switch for cutting off the 10,000-volt supply and a 30 or 40-hp General Electric three-phase induction motor direct connected by a vertical shaft to a Byron Jackson centrifugal pump, 15 to 20 ft. below the surface of the ground.

The exterior appearance of one of these pumping stations is shown in Fig. 1. The outdoor switch for breaking the 10,000-volt circuit is shown at the extreme left in this picture. It is a double break affair, with the movable part pivoted in the middle, so that one end swings up and the other down. The moving part carries a 36-inch fuse of No. 28 copper wire enclosed in a hard-rubber tube. The switch is operated by ropes from the transformer house, so that it cannot be tampered with. The transformer house, which is the building at the left, the interior of which is shown in Fig. 11, has the two transformers, the motor starting compensator and the fuses and switch in the motor circuit. The secondary switches are being equipped with an automatic device, not shown, for cutting off current in case the suction should fail, due to the temporary stoppage of the pump by interruption of the current supply. These devices will work by virtue of the water pressure,

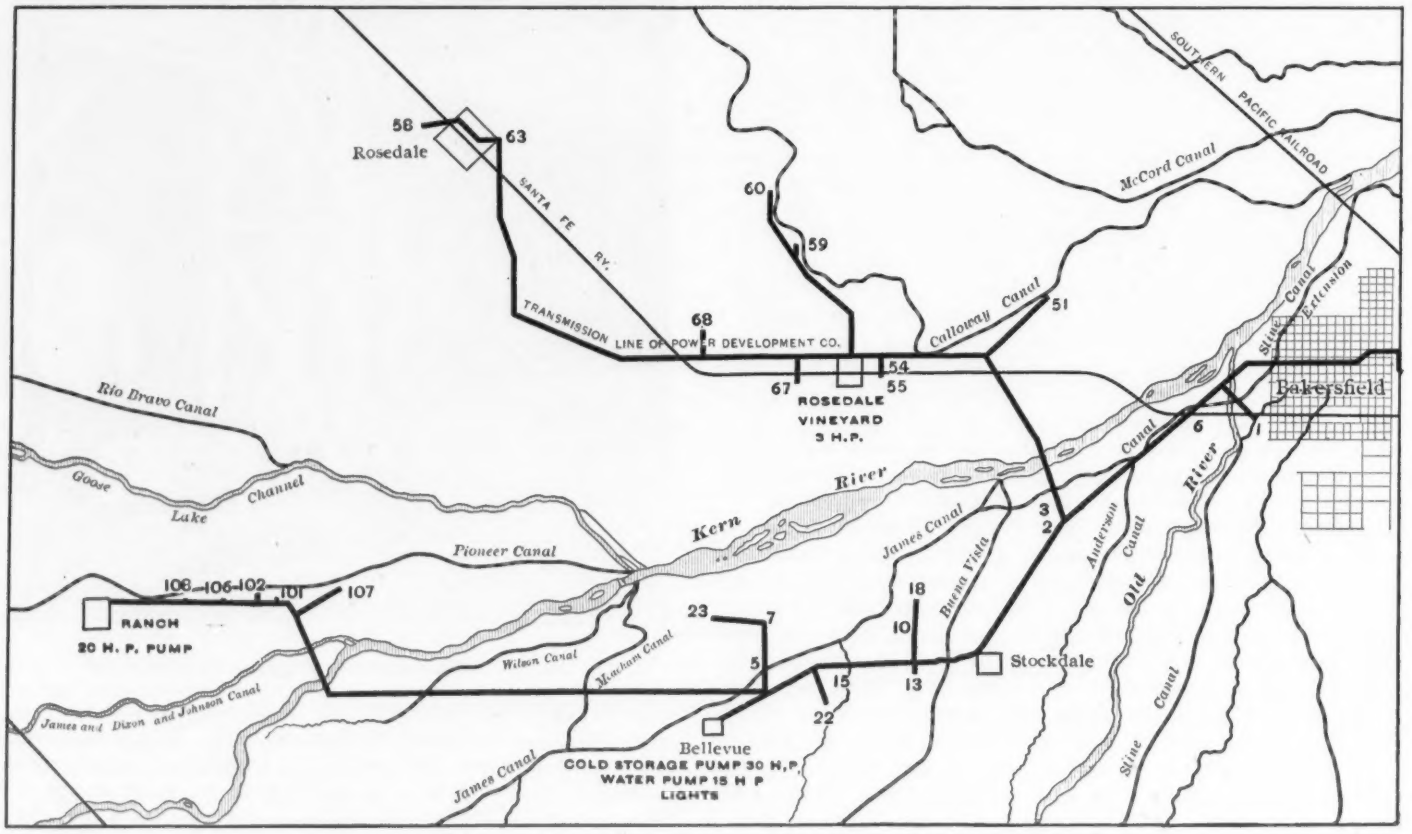
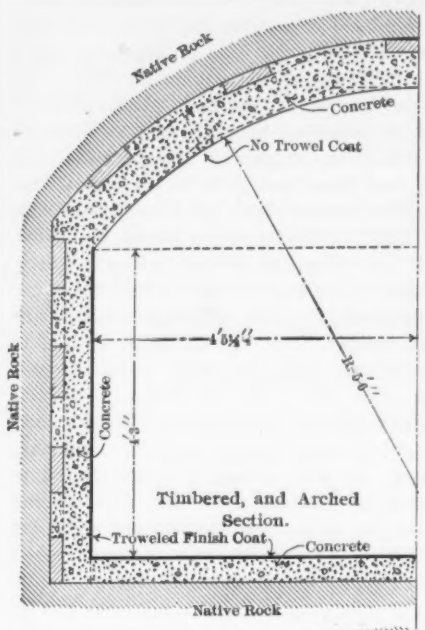
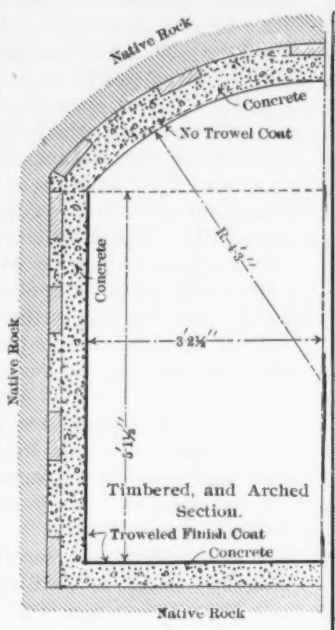


FIG. 4.—MAP OF PUMPING AND IRRIGATING SYSTEM.





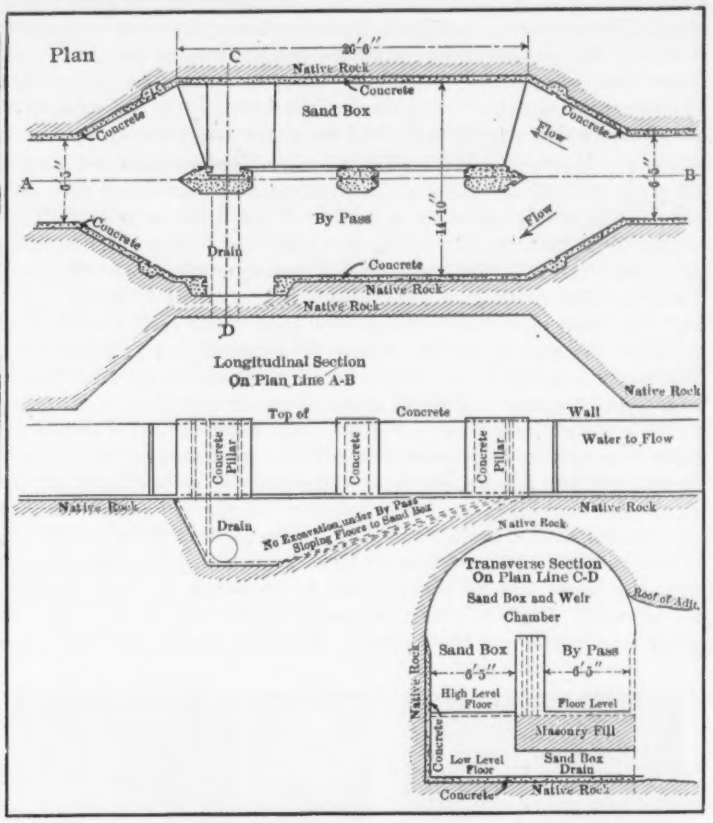
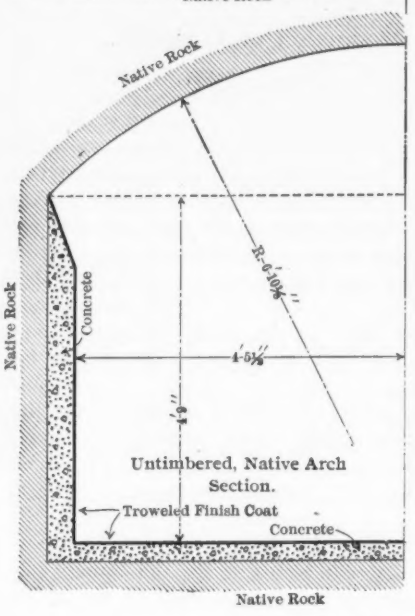
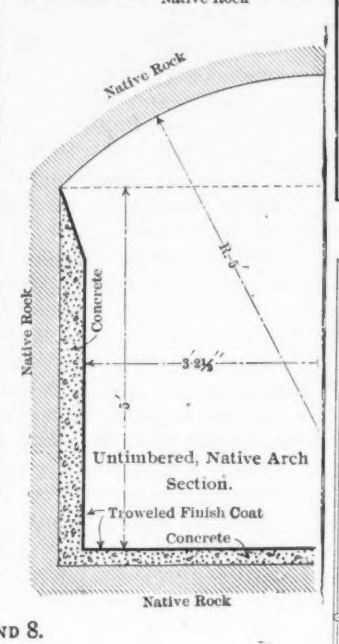
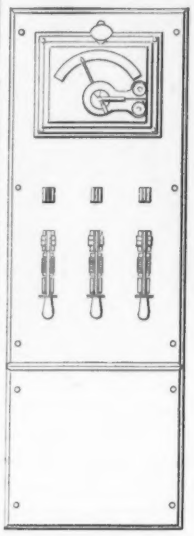


FIG. 10.





FIGS. 5, 6, 7 AND 8.



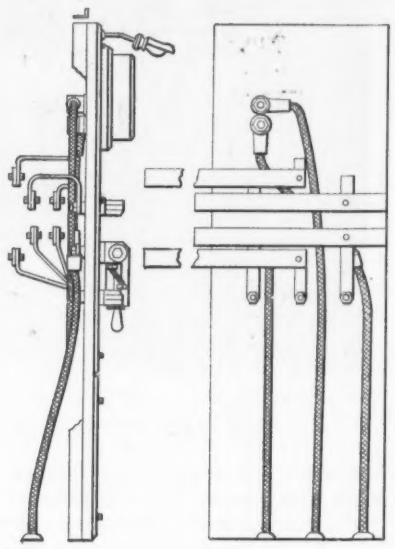
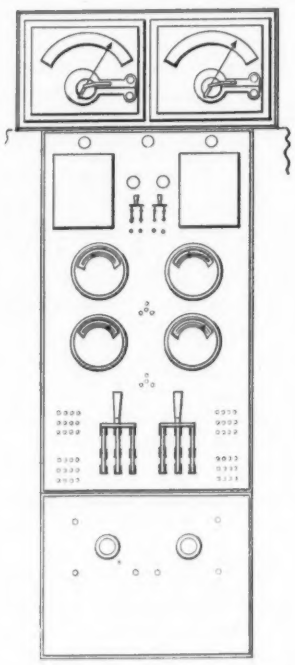


FIG. 11.



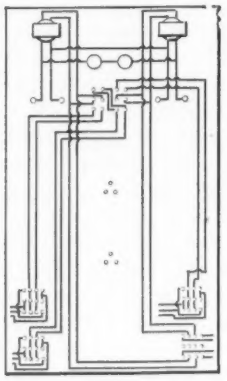
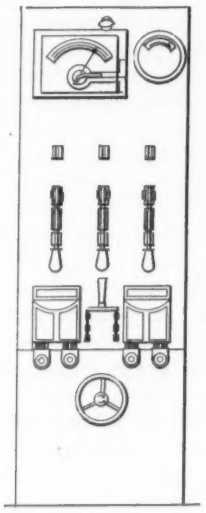


FIG. 9.



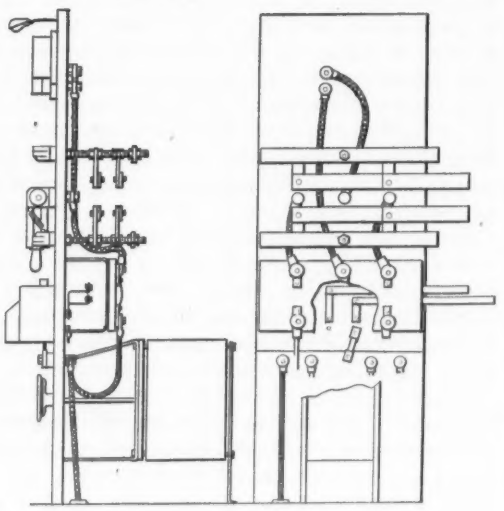


FIG. 12.

FIGS. 5 TO 12.—DETAILS OF CONSTRUCTION WORK AND OF SWITCHBOARD PANELS AND CONNECTIONS.

and if the water pressure supplied by the pump fails the switch will open. These pumps run many hours without attention, and while it is not desired that they run when the priming of the pump has failed, it is desired that they should not stop every time the voltage is dropped by a short circuit on the line as would be the case were a switch-opening device dependent on the current supply used.

The building at the right (Fig. 1) contains the motor and covers the pump pits. Four wells, about 60 ft. deep and 12 inches diameter, are sunk in a row about 12 ft. apart. A pit from 10 to 20 ft. deep is dug, so as to bring the pumps down as near to the water level as possible, because centrifugal pumps work much more efficiently when so placed. Fig. 2 illustrates the bottom of a pump showing the 8-inch galvanized steel suction pipe which connects the four wells to the pump, and the pump, framework and pressure pipe. The pump located in the pumphouse just above the pit is shown in Fig. 3, and a motor and pump mounted on an iron framework ready to be installed is shown in Fig. 2. The Kern County Land Company has done considerable testing and experimenting on the best form of pump for its purpose, and with the co-operation of the Byron Jackson Machine Works, of San Francisco, has settled upon the vertical shaft type illustrated as the best suited to its needs. As before noted, it is important to have a centrifugal pump down as near the water line as possible, for by so doing the best efficiency is obtained. With a direct-connected horizontal shaft pump the pump and motor must necessarily be placed above the high-water

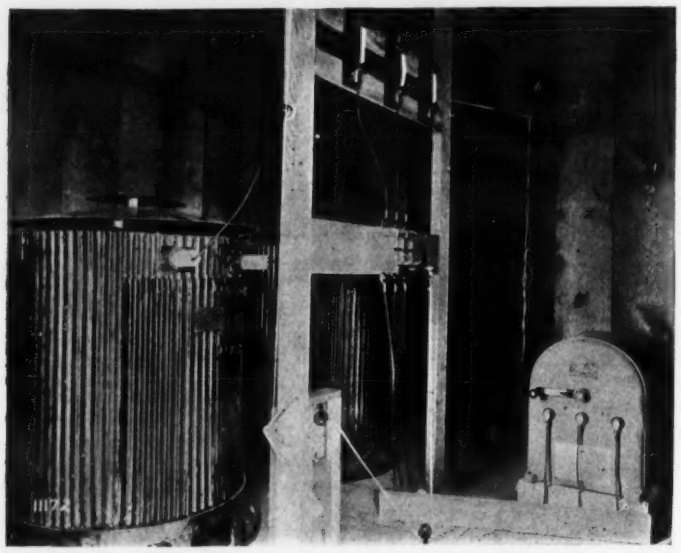


FIG. 13.—INTERIOR OF TRANSFORMER HOUSE.

line when the pump is not running. As the water always falls a number of feet in the wells as soon as the pump starts, this means that a horizontal shaft pump must always work with considerable suction, and hence inefficiently. By using a vertical shaft pump so that the motor can be kept up out of the water the pump can be put right down to water level or even below, and can be worked at nearly its maximum efficiency. The tests made by engineers of this company some time ago showed the efficiency of a vertical shaft centrifugal pump under the most favorable conditions to be 67 per cent. The efficiency of the horizontal shaft pump under the most favorable conditions under which they could be worked in practice was 57 per cent. This type of vertical shaft pump has a number of very interesting and important points. The runner or wheel of the pump is a solid casting with ports instead of a wheel with vanes. The suction pipe enters at the top and the runner is so close to the bottom of the pump and so close fitting in the chamber in which it runs (although it does not touch) that when the pump is running the suction and pressure act to entirely take the weight of the shaft, runner and armature so that practically no weight comes on the thrust bearing. The thrust bearing is at the top of the shaft on the motor. The oiling devices for the bearings are very ingenious. The motor has a hollow shaft, and as the oil runs through the bearing into a receptacle below the motor, it is picked up by a scoop on the shaft and forced by virtue of the speed of the scoop up through the shaft and into the bearing again. The iron frame work of the motor-pump combination is braced firmly by timbers in the pit, and the pumps run with practically no vibration.

It is found that a 30-hp motor will pump enough water to irrigate about 1 square mile of land. The average total lift of water from the well to the surface is about 25 ft. The pumps raise from 3½ to 5 cubic feet of water per second, depending on the lift. The discharge pipe is 10-inch galvanized steel. In each pump pit is a small piston pump, which can be belted to the motor shaft for priming the centrifugal pump when it is necessary. In operation one man looks after 10 wells, and two other men attend to 8 each. The pumps are run continuously, except when some of them have to be stopped on account of shortage of power. Each pump is visited by an attendant twice a day. A telephone circuit is run to each pumphouse on the transmission line poles. On account of the great number of instruments the telephones at the pumping stations are cut out by a double-pole baby knife switch (except when a man is at a pumphouse), to prevent having so many bells bridged across the line.

At present writing, the power load in pumping and other ranch uses is about full load for two 750-kw generators during the day, and some pumps have to be cut off in the evening to accommodate the lighting. The power factor in the middle of the day when the load is almost entirely induction motors, is said to be about 75 per cent. With the introduction of synchronous motors and a rotary connector this will, of course, be increased.

The Artificial Production of Graphite.

BY CLINTON PAUL TOWNSEND.

THE temperature of the electric arc itself has never been determined, but careful measurements of the temperature of the carbon terminals have been undertaken from time to time. Violle,[1] in 1893, having convinced himself by photometric methods that the temperature of the positive crater is the same whether produced by an arc of 10 or 400 amperes, determined the temperature of the positive terminal at the latter amperage to be 3500 degs. C. This estimate was based upon a direct calorimetric measurement of the heat given out by the detached tip of the electrode, and is subject only to the error in the value assumed for the specific heat of carbon.

Violle assumes, by reason of the peculiar constancy of the light emanating from the crater, that carbon is here at its point of vaporization, and has later,[2] employing a slightly different factor as representing the specific heat of carbon, determined this point of vaporization to be 3600 degs. C.

There does not lack evidence that the temperature of the arc itself is somewhat higher than that indicated for the terminal, but it is clear that the figure represents a near approach to the limiting temperature of the "arc" type of electric furnace, employing carbon electrodes and operating at atmospheric pressures.

Considering now furnaces of the "resistance" type, wherein the heat is developed by the resistance opposed to the current by a carbon rod or a mass of carbon granules, it is clear that the point of vaporization of carbon again sets a limit to attainable temperatures. Whether or not this limiting temperature is necessarily identical for arc and for resistance furnaces will be considered later.

At this limiting temperature we find a new chemistry. Compounds formerly considered unalterable by heat and elements regarded as infusible are melted and vaporized. Elements which at low temperatures are inert, display a varied activity, and others which at ordinary temperatures constitute our most active agents of chemical change, become relatively inert. Even the electro-chemical relations of the elements appear to undergo profound modifications.

The new field thus presented to the chemist has been carefully explored, with the result that no solid substance, element or compound, has been found to be both physically and chemically stable at the highest temperature attainable by means of the arc. It is the purpose of this paper to give some account of the modifications undergone by carbon, and of the conditions governing them, together with such inferences as may properly be drawn from the data at hand.

Since the original observation by Scheele in 1778 of the solvent power of molten iron for carbon, and the fact that a portion of the carbon so dissolved separates as graphite from the cooling mass, the conditions of the separation and its effect upon the physical properties of the metal, have been a part of the technology of the

[1] *Comptes Rendus*, Vol. 115, p. 1273.
[2] *Comptes Rendus*, Vol. 120, p. 868.

iron industries. For the present purpose it is necessary only to recall the observations by Moissan[3] that the purity of this graphite is proportional to the temperature to which the solvent metal has been heated, and to the pressure exerted by the iron in cooling. Graphite from this source, and, indeed, from all sources, contains hydrogen as an invariable constituent,[4] but not, it would seem, in chemical combination, for long heating in a vacuum suffices nearly or quite to eliminate it.

A method of forming graphite described by De Ville in 1847[5] consisted in passing a current of carbon tetrachlorid over molten iron, whereupon the iron volatilized as chlorid, while the separated carbon dissolved in the remaining metal. Owing to the elimination of iron the saturation point of the molten bath was quickly reached and graphite separated. Reference may also be made in passing to the production of graphite by a current of carbon monoxid over ferric oxid heated to 400 to 500 degs., and by the decomposition of carbon disulfid at high temperatures by metallic iron.

Despretz,[6] in 1849, undertook a careful study of the changes undergone by carbon at high temperatures, employing for the purpose a closed cast-iron vessel into which projected through leather stuffing boxes, two carbon electrodes. Pipes for the induction and eduction of gases were provided, and the effects of reduced and increased pressures were noted. In this miniature electric furnace, carbon, in its various forms, was interposed as a resistance in the form of rods, or was subjected to the arc. As a source of current Despretz employed 600 Bunsen cells, in series of 25, 50 or 100, as the exigencies of the work required—truly an expensive generator, but most efficient. He studied the behavior of retort carbon, of carbon derived from sugar and from turpentine, of anthracite coal, graphite and the diamond. His conclusions are thus summarized:

1. Carbon in a vacuum volatilizes at temperatures produced by 500 to 600 Bunsen cells. Under pressure of nitrogen at 2½ atmospheres volatilization occurs more slowly.
2. Carbon at these temperatures may be bent, welded, fused.
3. Carbon from all sources becomes progressively softer, finally turning to graphite.
4. Graphite volatilizes slowly.
5. Diamond is converted to graphite.

All of the varieties of carbon experimented with contained some ash, varying from 2 per cent in the retort carbon to .014 per cent in carbon derived from large, colorless crystals of sugar. Despretz recognizes no influence due to this admixture, but in the course of his article the following statement occurs:

"I have enveloped, I have impregnated, acicular rods of carbon with more fusible materials, silica, alumina, magnesia, to determine whether the presence of a more fusible body would render the fusion of the carbon more easy. The silica, magnesia and alumina escaped as vapors, and the carbon *remained unmodified.*" (est resté avec ses propriétés.) This is a clear and succinct statement of the modern method for the commercial manufacture of graphite, and that it should have failed utterly in Despretz's hands is extraordinary.

Despretz's treatment of anthracite coal was more successful, for he records its conversion to "well characterized graphite." This seems to have been effected by placing a lump of anthracite in a crucible and striking an arc to it.

The next systematic study of the direct combination and conversion of carbon was published in 1870 by Berthelot,[7] who had previously effected the synthesis of acetylene by means of an arc between carbon terminals in an atmosphere of hydrogen—a reaction which he accomplished not only with several varieties of amorphous carbon, but with graphite also.

Berthelot was unable to convert amorphous carbon to graphite by the action of heat other than that of the arc, nor could he accomplish the reverse reaction. The presence of chlorin or iodin did not determine either conversion.

Berthelot noted that the negative terminal of the arc, which has become thickened by the transport of carbon, yields much graphitic oxid, whereas but little can be obtained from the positive electrode —an effect not attributable, however, to the transport of carbon, since capsules of sugar carbon constituting the negative pole of an arc from 600 Bunsen elements, in an atmosphere of hydrogen, were largely converted into graphite.

[3] *Annales de Chimie et de Physique*, 7th Series, Vol. 8 (1896), p. 340.
[4] Ibid.
[5] Ibid. 3d Series, Vol. 49, p. 72.
[6] *Comptes Rendus*, Vol. 29, pp. 709-724.
[7] *Annales de Chimie et de Physique*, 4th Series, XIX., p. 392.

Berthelot's observations on the form taken by carbon liberated from its compounds under various conditions and by various agents, are of great interest. Hydrocarbons, subjected to heat, deposit amorphous carbon; decomposed by the electric spark, they yield amorphous carbon mixed with a small amount of graphite. Cyanogen gives precisely similar results. Berthelot remarks, referring to this admixture of graphite in the deposit by the spark: "I think that the amorphous carbon results from the decomposing action of the heat proper, and the graphite from that of the electricity." Recently Wilson and Fitzgerald[8] have published an observation curiously confirmatory of this, although not so recognized by them. Striking an arc between carbon terminals in an atmosphere of hydrogen containing hydrocarbons, they noted that "trees of soot and a deposit of hard graphitic carbon formed on this positive carbon, as if there were electrolysis of the hydrocarbon, and carbon were electronegative compared with hydrogen."

Chlorin, iodin and hydriodic acid were found by Berthelot to decompose methane without yielding graphite. Chlorid of carbon and carbon disulfid deposit, on the other hand, at redness, amorphous carbon together with considerable graphite.

It is to Berthelot that we owe the discovery that graphite may be obtained by the decomposition of a carbid. He heated the so-called carbid of boron—the "bore adamantin" of De Ville—with dry chlorin gas, and found that at a temperature below the softening point of glass carbon separates as amorphous graphite, and at the fusing point of porcelain as hexagonal crystals. This method uses a reagent capable of combining with the non-carbon constituent of the carbid, and seems in this respect more rational than the commercial process, in which a carbid is directly heated to a temperature at which the non-carbon element is volatilized. It is interesting to note that an analogous procedure has been recently developed by Bergmann[9] for the production of graphite from calcium carbid, the carbid, together with hydrogen peroxid, being gently heated under five atmospheres pressure; in the reaction which follows graphitic carbon separates. Acetylene reacts similarly with hydrogen peroxid. The method is not, however, of general applicability; aluminum carbid, for instance, heated with chlorin to dull redness, yields aluminum chlorid and a residue of amorphous carbon.[10]

Girard and Street in Paris have since 1893[11] practiced a method of superficially graphitizing carbon electrodes and other articles by causing an arc or a series of arcs to traverse the entire surface of the article, the operation being preferably conducted in a closed chamber, in an atmosphere of carbon monoxid, nitrogen or other neutral gas, or in a vacuum. The process is a commercial one, and the carbon to be converted is, of course, not free from ash.

Moissan, in 1896,[12] noted the production of graphite from a diamond heated in the arc, from the similar treatment of sugar charcoal preliminarily purified by chlorin, and of purified wood charcoal. He also noted the presence of graphite upon the tips of electric light carbons—all practical repetitions of the earlier observations of Despretz and others. Moissan also studied the solution of carbon in many metals—aluminum, silver, manganese, nickel, chromium, tungsten, molybedenum, uranium, zirconium, vanadium, titanium and silicon—and its separation therefrom, and in this connection made his classic observations on the formation of diamonds by the sudden cooling, in mercury or lead, of molten iron saturated with carbon. By this solution method also were reproduced the natural dilating graphites—"graphites foisonnants"—and it was noted that whereas, as a rule, graphite derived from carbon dissolved in fused metal dilates when heated in the presence of small amounts of nitric acid, that formed by the direct heating of carbon does not. The phenomenon was shown to be due to a brisk evolution of gas, probably derived from small quantities of unconverted carbon between the graphite laminæ.

Moissan[13] exposed to the direct action of an arc of 2000 amperes at 80 volts a carbon tube of 1 cm internal diameter, and thereby most beautifully demonstrated the volatilization and condensation of carbon. The interior of the tube became filled with carbon vapors which condensed upon its sides as a light deposit of graphite of great purity. Crystallized silicon placed at the lower portion of the tube fused and volatilized, and its ascending vapors, meeting the

[8] *Proc. Royal Society*, LX. (1896-7), p. 379.
[9] German Patent, 96,427.
[10] *Comptes Rendus*, Vol. 119, p. 16.
[11] German Patent, 78,926. *L'Eclairage Electrique*, 1895, 4, 454.
[12] *Annales de Chimie et de Ph.* 7th Series, VIII., pp. 306-347.
[13] *Comptes Rendus*, Vol. 119, p. 776.

descending vapors of carbon, united with them to form a network of transparent needle-like crystals of carbid of silicon. Reference will be again made to this experiment. Condensed vapors of carbon collected upon the furnace walls, or upon a water-cooled tube traversing the furnace likewise consisted entirely of graphite. This was also found to be true of the coating which forms slowly on the walls of incandescent light bulbs, and of that which is rapidly formed by the rupture of the filament.

All attempts to weld two pieces of carbon failed, even at temperatures at which it vaporizes freely; at normal pressures there is no intermediate liquid state.

Very recently Moissan[14] has directed attention to the production of graphite by solution of carbon in the carbids of neodymium and praseoymium. These carbids dissolve carbon freely at high temperatures, yielding graphite on cooling.

Moissan's conclusions from his varied researches relating to graphite have been thus stated by him:[15]

1. Whatever the variety of carbon, elevations of temperature always suffices to convert it to graphite. This graphite may be amorphous or crystallized, has a specific gravity of 2.10 to 2.25, and a temperature of combustion in oxygen of 660 degs. C.

2. There are several varieties of graphite, just as there are several varieties of amorphous carbon and of the diamond.

3. The stability of graphite (its resistance to oxidation), increases in proportion to the temperature to which it has been subjected.

4. This fact is clearly shown by the resistance opposed by different graphites to transformation to graphitic oxid. The difficulty of this oxidation increases in proportion to the fusing point of the metal from solution in which the graphite has been derived. Similarly, a readily oxidizable graphite like that of Ceylon becomes much more resistant after heating.

In connection with his well-known experiments upon the phosphorescence exhibited by diamonds when exposed to "molecular bombardment" in the vacuum tubes which bear his name, Sir William Crookes long ago observed that there occurs a discoloration or blackening of the surface of the gem; this he has more recently found[16] to be due to a superficial coating of graphite—a conclusion which has been confirmed by Moissan.[17] This graphite is so very resistant to oxidizing agents as to recall those specimens which have been subjected to the temperature of the arc. Crookes likewise calls attention to the fact that diamonds rendered phosphorescent by other means, as by exposure to the direct rays of the sun, to an electrical discharge in air, or to the Röntgen rays, are superficially darkened; possibly there occurs under these conditions also a minute transformation to graphite.

Acheson, in whose hands the manufacture of carborundum—carbid of silicon—has become an established industry, experimented in 1895[18] with a process for the purification of coke by direct heating by the electric current, volatilizing the impurities, and leaving the carbon thereby "in a practically pure state and with largely increased electrical conductivity"; probably a conversion, at least partial, to the graphitic state. Later in the same year he applied for a patent[19] for the conversion of carborundum into graphite by subjecting it to heat sufficient to volatilize the silicon.

The conversion is a striking one, the graphite often appearing as pseudomorphs of the familiar hexagonal plates of carborundum, and reproducing even the details of their striated surfaces. In this process the regular carborundum charge of coke, sand, salt and sawdust, the coke constituting about 50 per cent of the mass, was packed around a carbon core, and the current through the core so regulated as to first form, then decompose the crystalline carbid of silicon. Alumina, lime, iron oxid or clay may replace the silica, the corresponding carbids being successively formed and dissociated. It is stated also that magnesia gives similar results, but this may be questioned in view of the fact that magnesium forms no carbid by reaction with carbon at electric furnace temperatures. A confirmation of the reaction as regards lime has been since furnished by Moissan,[20] who produced graphite directly from calcium carbid by heating the latter substance in an arc of 1200 amperes at 60 volts.

[14] *Comptes Rendus*, Vol. 131, p. 595 (1900).
[15] *Comptes Rendus*, Vol. 119, p. 980.
[16] Chemical News, Vol. 74, p. 39.
[17] *Comptes Rendus*, Vol. 124, p. 653.
[18] U. S. Patent, 542,982.
[19] U. S. Patent, 568,323.
[20] *Comptes Rendus*, Vol. 126, p. 302.

An important forward step in the process is marked by the later observation of Acheson[21] that under proper conditions the action may become progressive, or pseudo-catalytic in character. If any form of carbon be mixed with silica, iron filings, or the oxids or oxy-salts of iron, the latter constituting not more than 3 per cent of the mass, there occurs a progressive formation and decomposition of carbid, and the vapors of silicon or of iron traverse the entire charge, combining with each molecule of amorphous carbon, and then abandoning it in the graphitic state for the next. The final escape of the iron, etc., from the furnace may be observed with the spectroscope.

It would seem that when the percentage of carbid-forming impurities is low the completeness of the conversion is conditioned upon their distribution throughout the carbon. In any mechanical mixture this necessarily fails of absolute uniformity, but Acheson finds[22] that certain natural carbonaceous substances, as anthracite and other non-caking coals, and certain carbonaceous products as willow charcoal, possess mineral constituents proper in kind, quantity and distribution to permit complete conversion of the carbon to graphite. At the close of the operation such mineral constituents are found to have been almost completely volatilized; for instance, an anthracite having 5.783 per cent of ash yielded graphite with an ash content of only 0.033 per cent. Reference has already been made to the conversion of anthracite coal to graphite by means of the arc, by Despretz a half century earlier.

Early in 1897[23] a series of observations were published by Borchers upon the weakening or bending of carbon resistance rods. The experiments were conducted in a closed electric furnace with water-cooled terminals and under high gas pressures. Under these conditions the carbon assumed a hard crystalline state, and the effect of impurities upon the crystallization was strongly marked. Borchers summarizes his observations as follows:

1. The more impure the carbon, the lower the temperature at which weakening occurs.

2. The harder and more crystalline the rod after cooling.

3. Broken edges of some carbon rods which have been used for heating charges composed of mixed carbon and oxids of metals, scratch quartz easily.

4. All materials which form "alloys" (legierungen), or more or less easily decomposable compounds with carbon, assist its crystallization.

As elements of this character he mentions boron, silicon, titanium, zirconium, vanadium, aluminum, the cerite metals, chromium, molybdenum, tungsten, uranium, manganese, iron and nickel, and refers to the probable efficacy of gaseous compounds of carbon with oxygen, hydrogen and sulphur. The distinction between this work and that of Acheson is stated to be that Acheson operated at atmospheric pressure, thereby requiring so high a temperature that "only graphite, not diamond," was obtained.

In 1899[24] Acheson published certain observations on the yield of graphite and his conclusions therefrom:

1. Comparatively pure petroleum coke produces practically no graphite.

2. Impure bituminous coal coke produces large quantities of graphite.

3. The larger the percentage of impurities in the bituminous coal core, the greater the yield of graphite.

4. Only part of the carbon core of carborundum furnaces is converted into graphite (that part which carries an admixture of slate or a high ash content). This conversion is not increased even by repeated use of the same grains in successive furnaces.

Acheson's conclusions follow:

1. *Graphite* is the form carbon assumes when freed from chemical associations under conditions of low pressure and protection from chemical influence.

2. *Diamond* is the form carbon assumes when freed from chemical associations under the conditions of high pressure and protection from chemical influence. And "by inference"

3. *Amorphous carbon* is the form carbon assumes when freed from chemical associations under conditions of high or low pressure and exposure to chemical influence.

The precise meaning of the expression "chemical influence" as employed above with reference to a substance separating out in

[21] U. S. Patent, 617,979.
[22] U. S. Patent, 645,285.
[23] *Zeitschrift für Elektrochemie*, III., p. 393.
[24] *Journal of the Franklin Institute*, Vol. 147, p. 475.

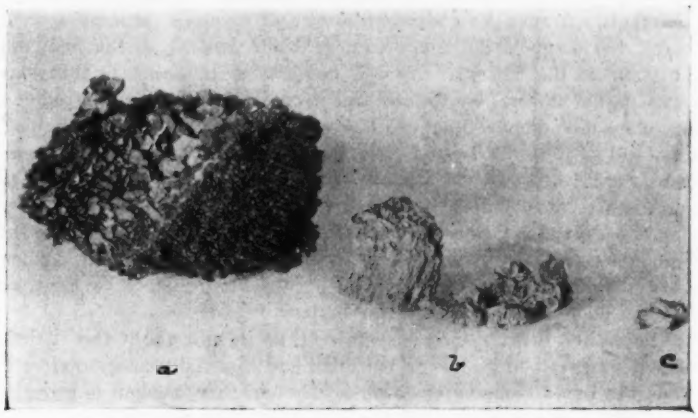
elemental state is not clear, even from the context, and the invalidity of the inference as a logical deduction is patent.

It would seem that no adequate theory regarding the several modifications of carbon, and particularly with reference to the relation between the so-called allotropic forms, amorphous carbon and graphite, has been offered.

Graphite and amorphous carbon present a relationship for which we find no close analogy in other elements. Not only do they differ in their specific heat and in their heat of combination with oxygen, but graphite is capable of yielding by oxidation a solid compound, graphitic oxide, which is eminently characteristic. Furthermore, and perhaps most important, the two modifications cannot be considered as phases in equilibrium at a fixed temperature, for although amorphous carbon is readily convertible to graphite, the reverse transformation does not occur.

As regards the artificial production of graphite, it will be noted that there is at least an apparent conflict between the results of different experimenters, and there is a real conflict between their expressed conclusions. Moissan states definitely: "Whatever the variety of carbon, elevation of temperature always suffices to convert it to graphite." Acheson finds it impossible to effect the conversion with relatively ash-free petroleum coke, notes that those coke granules which escape conversion in the first carborundum furnace, remain unchanged in succeeding furnaces, and believes that the formation and decomposition of a carbid is an essential part of the process. The conclusions of Despretz agree with those of Moissan, as do also the results of Berthelot. Borchers appears to be in close agreement with Acheson.

It should be borne in mind that both amorphous carbon and graphite are very highly polymerized bodies, and that the polymeri-



A.—Crystallized Carborundum. B.—Graphite pseudomorphs of Carborundum Crystals. C.—Graphite Granules from Coke Coal of Carborundum Furnace.

THE MANUFACTURE OF GRAPHITE.

zation of either depends upon the temperature to which it has been subjected. Moissan[25] found that lampblack was attacked by an oxidizing mixture—sulfuric acid and potassium bichromate—at 60 degs. C., and took fire in oxygen at 371 degs.; after five minutes calcination at 910 degs. the corresponding figures were 90 degs. and 440 degs. Three hours heating gave a new product, oxidized by the mixture at 95 degs. and burning at 476 degs., and after six hours heating the data obtained were 99 degs. and 506 degs., respectively. The similar results with graphite, showing the effect of temperature upon its oxidizability have been already quoted. That the difference between the two forms is more than one of *degree* of polymerization, is indicated by the absence of intermediate states and by the sharp distinction in properties, both chemical and physical.

Referring again to that experiment by which Moissan demonstrated the volatility of carbon in the arc, it will be recalled that the vapors so produced were caused to mingle with vapors of silicon, and that a bridge, consisting of a network of crystals of carbid of silicon, formed between the carbon and the molten silicon. Since this reaction could occur, the temperature of these vapors was below that at which carbid of silicon is decomposed; that is to say, below that of the Acheson graphite furnace. But inasmuch as the temperature of both arc and incandescent furnaces is limited by the point of vaporization of carbon, we can only conclude that this point of vaporization is lower in the arc than when the carbon is directly heated by inclusion as a resistance in the circuit. This effect is to be ascribed to the action of the arc in reducing the complexity of the carbon molecule, and thereby increasing its volatility. It would perhaps be accurate to define the limiting temperature of the arc between carbon electrodes as that temperature at which the complex carbon molecule breaks down, and that of the carbon resistance furnace as the true point of vaporization of carbon, the former temperature being distinctly lower than the latter.

There is evidence that the carbon of the arc terminals is not only depolymerized, but is *ionized*. For if the vapors from the two poles be separately withdrawn, they are found to be oppositely charged, those from the positive pole carrying a negative charge and vice versa. This is considered by Chéneveau[26] to indicate that the ions proceed from the electrodes themselves. Merritt and Stewart[27] have found that these vapors retain their charges for the relatively long period of 10 seconds after withdrawal from the arc.

I am inclined to believe that the preliminary ionization of the carbon is essential to the production of graphite. For it will be noted that when Moissan speaks of "elevation of temperature" he means the heat of the electric arc, whereas Acheson and Borchers refer to heat developed in a carbon resistance. In the former case conditions favorable to the ionization of the carbon are present, while in the latter such effects are, so far as we know, definitely excluded. Acheson's failure to effect the conversion of pure carbon cannot, as we have seen, be ascribed to the employment by him of too low a temperature, for in Acheson's furnace carbid of silicon is decomposed, whereas Moissan *formed* this compound by the union of silicon with carbon vapors—vapors which, when condensed, yielded "graphite of great purity." Moissan's production of graphite was therefore effected at a temperature lower than that at which Acheson found carbon to be unchanged.

Other of the observations before referred to tend to confirm the view that the production of graphite is due to more than the simple heat effect of the current; Berthelot's supposition that the mixture of the two forms of carbon which results from the passage of an electric discharge through hydrocarbons and cyanogen is due to the joint action of heat and electricity, appears eminently probable, and finds confirmation in the work of Wilson and Fitzgerald. If we re-examine the work of Despretz we find that whenever the arc was used the transformation to graphite was readily accomplished, even though the ash content of the carbon were only one part in 7000; but when the carbon, as a filament, was directly included in the circuit, the results are less positive, and the production of graphite seems to follow either the presence of a large admixture of ash, or the rupture of the filament.

The essential condition for the formation of graphite, then, may be considered to be the presence of carbon in the ionized state and its separation therefrom. This, so far as we know, may be accomplished by any one of four methods:

1. By solution in metals or carbids.
2. By the direct ionizing action of the electric discharge, and notably the arc, upon carbon.
3. By the action of the electric discharge upon gaseous carbon compounds.
4. By the dissociation by heat of certain carbon compounds, notably the carbids.

These four general methods embrace all of the special cases heretofore described.

Is it possible that carbon may be separated from the ionized state in an unpolymerized non-graphitic form? Coehn[28] has recently stated that he has succeeded in dissolving carbon, and separating it as cation from its solutions. Starting from the observation of Bartoli and Papasogli that a carbon anode in surfuric acid yields a yellow or brown liquid, with evolution of oxygen, carbon monoxid and carbon dioxid, Coehn found that by properly choosing the concentration and temperature of the acid and the current density he was able nearly to suppress the evolution of oxygen, producing the yellow solutions referred to, and a mixture of anode gases, consisting of about 70 per cent carbon dioxid, 30 per cent carbon monoxid, and not over 1 per cent of oxygen. From this solution there separated upon the cathode a dense and adherent coating, having the appearance of carbon, and giving its reactions in the flame and with oxidizing agents. Analyses of the precipitate have not been published, but are stated to show the presence of both hydrogen and oxygen, indicating, according to Coehn, either the presence with the

[25] *Annales de Chimie et de Physique.* 7th Series VIII., p. 294.

[26] *L'Eclairage Electrique XX.* (1899), p. 401.

[27] *Physical Review,* VII. (1898), p. 129.

[28] Coehn, *Zeit für Elektrochemie,* II., p. 541; III., 424. Vogel, Ibid., II., 581.

carbon of a solid conducting carbohydrate, or of a "kind of water of crystallization." Coehn's results appear too fragmentary to serve as a basis for definite conclusions, or to support his contention that we have in his solution carbon as an ion, or in his deposit, the element itself as a simple cation.

Concerning the properties of the simple element carbon we can only speculate. Berthelot[29] having in mind not only the progressive polymerization of carbon, but also the constant presence of hydrogen, said that carbon, as known to us, seems to present less the characteristics of an element than of the extreme condensation product of the hydrocarbons: "Indeed, carbon is not comparable to a true simple body, but rather to a hydrocarbon, extremely condensed, extremely poor in hydrogen, and of extremely high equivalent (à équivalent extrêmement élevé). Pure carbon is in a way a limiting condition, which can scarcely be realized under the influence of the highest temperatures which we are able to produce. As it is known to us in the free state, it represents the extreme term of molecular condensations, that is to say, a state as far removed as possible from that of the element carbon, brought to the condition of a perfect gas and comparable to hydrogen."

However this may be, it is highly probable that non-polymerized carbon, whether or not a gas, would present new characteristics, entering into reaction at ordinary temperatures, affording by its combinations a ready source of electrical energy, and giving us an insight not otherwise attainable into the chemical processes of living organisms.

Storage Battery Maintenance.

By Thos. J. Fay.

In the maintenance of storage batteries there are a number of important considerations, but none more important than the preservation of the purity and strength of the electrolyte; that is, provided the materials furnished for the installation are originally pure. This may not always be the case, for even the most scrupulous manufacturer will have little mishaps, and 100th of 1 per cent of nitrate can easily find its way into the finished product where, unless it is discovered by the battery operator and promptly removed, it will soon put the positive plates out of commission owing to the "formation" continuing; as a consequence the plates will "grow" and finally disintegration will set in through the plates lacking in "backbone."

As a further illustration of a possible cause of deterioration, take, for example, a "chloride" battery. The process involved in the manufacture of this type of battery is as follows: Finely powdered metallic lead is dissolved in nitric acid, from which it is precipitated in the form of lead chloride by the addition of hydrochloric acid. The precipitate is removed, washed and fused with zinc chloride, and in the molten state is run into molds, thus forming pastilles, 5-16 by ¾ by ¾ inches, or thereabouts. The pastilles are set up in molds, and the metal for supporting grid poured into the same under pressure, thereby increasing the density of the metal, which is a lead-antimony alloy. The plates are then packed between zinc plates in a bath of zinc chloride solution and short-circuited, with the result that the chloride is extracted for the most part, the remaining chloride being removed by washing the plates in running water. It is perfectly obvious that any lack of attention on the part of the workmen who have the work in hand will result in chloride being present in the finished product; indeed, this often occurs, and unless the presence of chloride is noted by the operating force the ill effects of chloride will soon be manifest, and the life of the battery, so contaminated, will be put in jeopardy.

On the other hand, take a battery of the Planté type involving the electro-chemical process of formation. In this type of battery the plates are first cast or spun, thus increasing the surface in the ratio of, say, 20 to 1. That is to say, a plate having one square foot of superficial area is so spun, scored or grooved as to increase the surface, say, to 20 square feet, or the plate may be cast and a similar result obtained. The plates are then placed between dummies in a nitrate bath and a current of electricity sent through them as positives for a sufficient length of time to "grow" the active material out of the plates themselves, almost to any desired thickness. The result is a supporting grid of pure metallic lead, with the spaces between the leaves completely filled with active material (lead peroxide), the object of the nitrate being to hasten the formation. The plates so formed are removed from the nitrate bath and washed thoroughly in running water. They are then set up in a dilute sulphuric acid bath and formed as negatives, under which condition all remaining impurities are cast off. The plates are again removed, washed, and plates intended for positives are reformed in a dilute sulphuric acid electrolyte between dummy negatives. After this process is completed, the plates are removed, trimmed, the necks burned on and the elements are set up into jars or tanks, the cross-bars and interconnecting straps burned on, and the jars or straps filled with electrolyte of the proper strength, when the process is completed, and the plates are ready for the initial charge and discharge of the completed battery.

It is possible that by careless workmen, or in the rush to fill orders, the process may be slighted; or to economize, the electrolyte may be kept in service too long—all resulting in the presence of nitrate in the completed battery. It is important that battery operators shall guard against this contingency, and to do so, a test for nitrate be applied to every element promptly upon receipt of a battery, and if the nitrates be present to reject the battery or remove the nitrates, otherwise the forming process will go on, the plates will "grow," the supporting grids will be reduced and the life of the battery will be but short. It is a fallacy to assume that "only a trace of nitrate is present, and it can be of no great consequence." As a matter of fact, the regular nitrate forming bath carries but a small percentage of nitric acid, and as the primary reduction takes place in from 20 to 40 hours, 100th part of 1 per cent in the working electrolyte will be felt in but a short time.

It might be asked, if the nitrate formation and the chloride process are so fraught with dangers, why not use some other process? The writer fails to observe that the horse would be of any other color, if through careless workmen or a press of business a taint of the forming solution is present in the finished product. There could be but one result, and that is a continuation of the "forming" process, always to the detriment of the supporting grid and leading to the final destruction of the battery. Now it happens to be the case that batteries, under normal conditions free from any "forming" ingredient, last none too long; in fact, no one ever heard of a centenarian battery, and so it would seem as if all who have the care of batteries in hand should not only be capable of making tests for contaminating ingredients, but should be provided with suitable instruments and reagents. This alone, however, is not enough, for they should take the time necessary and systematically and frequently test for iron, copper, chlorine, nitrates, mercury and such other ingredients as have no rightful place in the make-up of a battery.

The writer, who spends his entire time in and about the various establishments using storage batteries and especially automobile stations has never come across a place wherein this problem is properly met, while he can name a dozen places wherein tests for impurities are never made, where the equipment for making tests is conspicuous by its absence, and where skill in the matter of tests of this sort is as yet undeveloped.

It is with the hope that the soul of the artist may be awakened in the many battery men who now go blindly on ruining good batteries because "they know not what they do," that the writer raises this question, and here submits some simple tests. There are, no doubt, more simple methods, and it may be others will contribute their quota, thus giving "battery men" the option of choice as between methods. The following tests for undesirable ingredients will be found simple and inexpensive, as respects the equipment required.

TESTS FOR CHLORINE.

The presence of chlorine in the electrolyte may be noted from the fact that a few drops of a solution of nitrate of silver in a test tube of the electrolyte to be tested will produce a curdy white precipitate of silver chloride which is solvable in ammonia and precipitated by nitric acid. Silver chloride melts to a horny mass and on exposure to light turns violet.

TEST FOR IRON.

Iron salts are known by the proto salts being green, and their solutions giving a dark blue precipitate with red prussiate of potassium. The per salts are foxy red, and their solutions yield a dark prussian blue with yellow prussiate of potassium. A few drops of each of the prussiate solution in separate test tubes of electrolyte will disclose the presence of iron salts, *proto* or *per*, as the case may be.

TEST FOR COPPER.

The copper salts are known by their solutions yielding, with liquor potassæ, a blue precipitate which turns black on boiling, and with a solution of ammonia, a bluish-white precipitate which is dissolved and

[29] *Annales de Chimie et de Physique*, 4 Series, IX., p. 475.

forms a beautiful sapphire blue solution with excess of ammoniacal solution. They also give a chocolate precipitate with ferrocyanide of potassium.

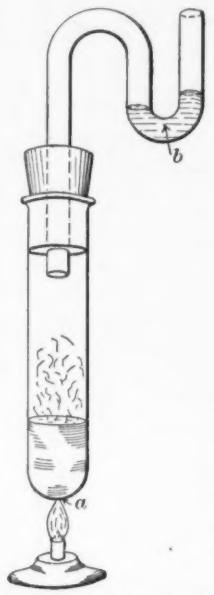
A few drops of liquor potassæ in a test tube of electrolyte will first show the bluish precipitate, if copper be present. The proof of this lies in the fact that the precipitate will blacken on boiling. The ammonia test can be made in a separate tube at the same time, using another quantity of the same sample of electrolyte, although the potassæ test will be conclusive in itself.

TEST FOR MERCURY.

The mercurous salts are known by giving a black precipitate with lime water, and an olive green precipitate with iodide of potassium solution. The mercuric salts give a yellow precipitate with lime water and a scarlet precipitate with iodide of potassium. Users of hydrometers having a mercury bulb are nearly sure to have mercury in the batteries. Thermometers are, of course, open to the same criticism, but to a less marked degree, because thermometers are somewhat less fragile.

TEST FOR NITRATES.

(a) In a test tube holding 25 cms of electrolyte add 10 grams of proto-sulphate of iron solution, add carefully 10 cm of concentrated, chemically pure, sulphuric acid. The presence of nitric acid may be known from the fact that a brown stratum will appear between the electrolyte and the concentrated sulphuric acid. The intensity of the color will denote the quantity of the nitrate present.



NITRATE TEST TUBE.

(b) A more satisfactory test can be made as follows: Referring to the accompanying illustration, place the electrolyte to be tested with some chemically pure copper filings in the test tube *a* and a few drops of proto-sulphate of iron solution in the bent glass tube *b*. Apply heat to the tube *a* when, if nitrates be present in the electrolyte, the color will change to a blackish brown. If, however, much chlorine be present, this test fails, in which event proceed as follows:

(c) Add a small amount of gold leaf and somewhat more of concentrated hydrochloric acid to the electrolyte, then boil the mixture. If gold is dissolved the presence of a nitrate is indicated, the smallest amount of gold dissolved may be discovered upon adding to the liquid a few drops of proto-chloride of tin, which develops the purple of cassius.

The best way is to test the electrolyte for chlorine first, and if the same is found to be present, then proceed with the "gold" test for nitrates; but if no chlorine is found, the proto-sulphate of iron test can be substituted, if the operator so desires.

There are other objectionable ingredients which, if found in a lead-sulphuric acid battery, would lead to complication. They do not predominate, however, excepting in rare instances, and their effect is not so marked as that produced by the compounds above listed; therefore, no space will be taken here in a further discussion of possible impurities.

It might be well to add, however, that contamination may be due to impurities in the plates, in the acid or in the water. More often, however, impurities are due to the surroundings; that is to say, a battery is put into a vehicle, for instance, in which bolt heads are exposed; it is but a question of a few days when the corroding effect of the acid fumes will be noticed and the iron salt, cast loose, will fall into the battery. The practice of using water from the city mains also leads to a goodly supply of iron and whatnot.

The safe rule, in view of all these possible sources of trouble, is to proceed as follows:

(a) Test the battery when first received for the given list of impurities. If the battery comes "knocked down" or "dry," test the plates.

(b) Test every carboy of electrolyte received before any of it is used, and, above all, do not purchase electrolyte made from iron pyrites. The only suitable electrolyte is made from sulphur for the acid and distilled water for diluting.

(c) Do not have concentrated sulphuric acid around, as some careless person may put it into the battery either to bring up the strength of the electrolyte or by mistake.

(d) Use only distilled water from carboys, not from barrels, and test every carboy of water received before using.

(e) Keep the electrolyte up to strength in the batteries by the following process:

1. Add distilled water to reduce the strength.
2. Add 1400 specific gravity electrolyte to increase the strength.
3. Test for acid strength always with a fully charged battery.

(f) Temperature has a marked effect on battery output and acid strength, hence observe the temperature at which all equalizing of electrolyte is done, and either compensate for temperature or wait until the temperature is at some predetermined point, say, 75 degs. F.

In conclusion, it may not be out of place to give a list of re-agents used in qualitative analyses, and a statement as to their mode of preparation. This list is far from complete, but will be all that is required for every-day practice in the battery room. It is worth while to add, however, that if impurities are discovered, they must be eradicated, else tests will be *"pour passer le temps."*

RE-AGENTS. Formula.	Name.	To Make Solution, Proceed as Below.
$Ag\ N\ O_3$	Nitrate of silver.	1 part salt, 20 parts water, in orange colored bottle.
$K_3\ Fe\ Cy_6$	Potassium ferricyanide, Red prussiate of Potassium.	1 part salt, 12 parts water.
$K_4\ Fe\ Cy_6$	Potassium ferrocyanide, Yellow ferrocyanide.	1 part salt, 12 parts water.
$N\ H_3$	Aqua ammonia, Ammonia water.	Purchase 16 degs. B., in glass-stoppered bottle.
$K\ O\ H$	Liquor potassæ.	Purchase ready for use, green glass bottle.
$Ca\ H_2\ O_2$	Hydrate of calcium and water, Lime water.	½ grain of lime to 1 oz. of water.
$K\ I$	Iodide of patassium.	1 part salt to 20 parts water.
$H_2\ S\ O_4$	Concentrated sulphuric acid.	Purchase 66 degs. B. sulphuric acid.
Cu	Copper filings.	Purchase test copper.
$Fe\ S\ O_4\ 7\ Aq$	Green vitriol, Proto-sulphate of iron.	1 part salt, 8 parts water.
Au	Gold leaf.	Purchase as required.
$H\ Cl$	Muriatic acid, Hydrochloric acid.	Purchase concentrated acid in glass-stoppered bottle.
$Sn\ Cl_2$	Proto-chloride of tin.	1 part salt, 10 parts water.

Dowered Telegraphers.

A question put in the British House of Commons elicited the fact that the Postmaster-General encourages matrimony among women employees of his department by giving them marriage portions. As much as $50,000 has been given away in this manner in a single year. Women enter the Government Postal Service as telegraph operators at an average age of 16. By the terms of the Treasury minute regulating the compassionate allowance scheme, as it is officially called, a woman is entitled to the allowance after six years of service. That is to say, she has reached the marriageable age of 22, when she is first entitled to her dowry from the State. For each year of service she can ask one month's pay. At the end of a woman's sixth year of service, when she is at her best as a telegrapher, she receives no more than $25 a month, so that if she should marry forthwith her compassionate allowance would amount to just $150. If she should wait until 28, she would then be entitled to 12 months' pay, or the maximum amount of allowance, whichever worked out to the smaller sum, the official maximum being $400. As a matter of fact, the average amount paid has been found in practice to be about $200.

The Institute Membership.

American Institute of Electrical Engineers has 1240 members, of whom 690 live in the States of New York, New Jersey, Pennsylvania and Massachusetts. New York has 416, California has no fewer than 51. There are 38 in England, 28 in Mexico, 7 in Hawaii, 7 in Australia, 6 in South Africa, 3 in Brazil, 3 in Austria, 3 in Holland, 10 in Japan, 2 in the Philippines and 2 in New Zealand.

Firemen and Electric Shocks in Italy.

By Guido Semenza.

DURING recent years cases have been reported of firemen receiving shocks from electric lighting conductors while engaged in extinguishing a fire. Such shocks have been attributed to the conductivity of the stream of water from the hose coming into contact with the wires, and as a result firemen have come to view electric conductors as a source of real danger from this cause. To those who are aware of the small conductivity of pure water, a shock from the cause attributed does not seem very probable for the reason that a column of water of the size which comes from a nozzle must have a notably high resistance. It might, however, be asserted that some phenomenon due to electric capacity may account for the shocks which have been received, and in order to determine this question the writer performed some experiments with the aid of the Milan Edison Company, which kindly offered the use of its laboratory for this purpose.

In this laboratory there are available direct current at voltages varying from 2 to 550, and alternating current at 42 cycles and 4 voltages varying from 10 to 3000 volts; besides a connection can be made with an electric railway circuit and with a three-phase, 3600-volt network. The trials made were of two kinds—with direct current and with alternating current. The experiments took place in a large yard quite close to the laboratory, in which a plate of metal about a yard square was placed in a slightly inclined position on porcelain multiple petticoat insulators. This sheet was connected to one of the conductors, the other of which was well earthed. The experiment was performed in the following manner:

A fireman, with his boots and bottom part of his trousers wetted, placed himself near the spot where the wire was grounded, and directed a jet of water from a nozzle against the metal plate, holding with bare hands the metallic nozzle. The water was supplied by a steam pump at a pressure which could be made as high as 180 lbs. to the square inch. The voltage was measured in the laboratory with the necessary instruments, and at intervals the voltage between the metal plate and the earth was determined so as to be sure that a good earth connection was being maintained.

Before passing to a description of the experiments it should be said that though the results of the trial have a great practical value from giving a sure measure of the dangers to which firemen may be subjected, on the other hand, they cannot be considered exact from the scientific point of view for the reason that one of the testing instruments was necessarily human organism. As is well known, a large difference as to sensibility exists between different persons with respect to electric shocks. It was found, for example, that the length of water jet at which different firemen began to feel the current, varied as much as 50 per cent, and the length of the jet at which shocks could be supported, varied considerably with different men. Besides, it was found that the sensibility of the same person varied within certain limits from day to day, and that those accustomed to receive shocks have a lesser sensibility to them. As the results obtained were thus affected by the human element, the experiments consequently cannot be claimed to be of a scientific order, though sufficiently decisive for practical purposes.

Direct current was supplied from a storage battery of 250 cells, and the voltage varied by connecting up the cells in different ways. Sensations were not felt up to 200 volts. At 200 volts a slight pricking in the hands was experienced when the pipe was approached to within about an inch of the metallic plate; indeed, in order to render the sensation surely perceptible, the nozzle had to be moved so that the jet touched the plate intermittently. A shock was then felt owing to the resulting opening and closing of the circuit.

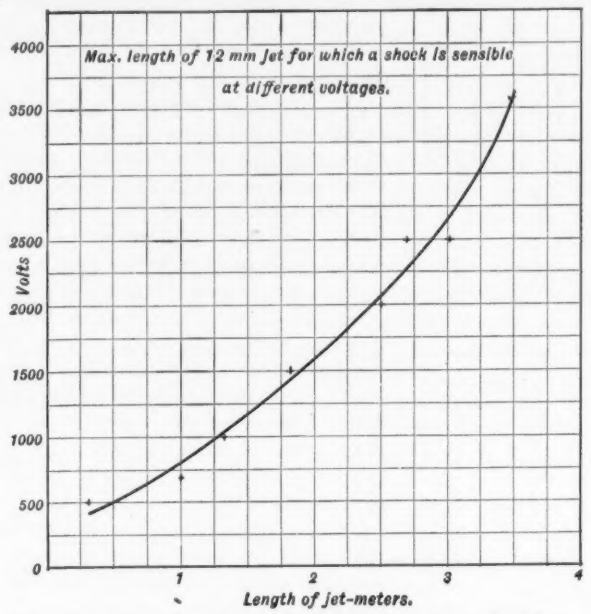
Upon raising the voltage gradually to 500 volts, the distance at which one began to feel slight shocks rose to 2½ to 3 inches. Nozzles of various diameter were then tried, and with a jet from a nozzle 2 inches in diameter shocks began to be perceptible with a length of jet slightly over 3 ft.

As these experiments partook of a laboratory character, to remove any doubt that could arise as to the influence of the self-inductance of the machines or the capacity of the lines, the experiment was repeated by directing the water jet on a trolley wire in service. The fireman climbed a wooden structure, with one hand grasped a wire having a good connection to the track rail, and with the other hand held a nozzle which directed a jet on the trolley wire. The results were identical with those obtained in the laboratory.

During the experiments with alternating currents, the current was obtained from a transformer with a ratio varying from 1-1 to 1-4, the upper limit of the voltage being 400. Above 400 volts an alternator was used. Experiments could thus be made at any voltages from 40 up to 3600, the frequency in every case being 42. Trials were made with nozzles of different diameter and with jets under different pressures.

With a jet from a ½-inch nozzle under such a pressure that the column of water reached its destination without breaking, the first sensation was at 40 volts with the nozzle at about 1 inch from the plate. With the increase of voltage the distance gradually increased and at 500 volts it was about 7½ inches. The shocks from alternating current are therefore perceptible sooner than with direct current, as was to be foreseen; and the sensation is also different, the direct current giving an instantaneous shock upon opening and closing the circuit, while the shock from the alternating current is continuous and gives a sensation of strong pricking.

The accompanying diagram shows the curve relating to the length of the water jet at which the shock becomes perceptible with the voltage, and referring to a ½-inch nozzle. Though the curve, for reasons above pointed out, is lacking in mathematical precision, still it gives a sufficiently clear idea of the case, and from it can be noted that the effect is smaller for a given percentage increase of length of water jet than it is for the similar increase of the voltage.



CURVE SHOWING RELATION OF WATER JETS AND VOLTAGE.

The maximum value of the voltage used was 3600 volts, and at this tension a sensation was perceptible at a distance of about 10 ft. A person of average sensibility can endure the sensation from this voltage without great inconvenience up to a length of jet of about 3 ft. The section of the jet, however, notably changes these distances. Thus, with a 2-inch jet the shock is perceptible for 500 volts at 8 ft., and with 3600 volts it is quite strong at 24 ft.; at 13 ft. it becomes quite intense and nearly reaches the limit at which it may be supported by a person of average sensibility. The form of jet has a great influence, which can be easily understood. A continuous jet must offer very much smaller resistance to the current than one which breaks or scatters. This was quite clearly shown by experiments. With equal lengths of water jet the sensation is stronger the smaller the velocity, as with the smaller velocity the stream is much more compact. This explains why the shock increased less rapidly than the voltage; in fact, the greater the distance the less easy it is to maintain a compact jet.

After having finished the experiments in the manner above described, tests were made to see if the effects of the capacity of a system of high-tension cables, transformers and motors, such as may form part of a city distribution, might introduce any changes. For this purpose one of the conductors of the three-phase distribution of Milan was put into communication at 3600 volts with a metal plate and a water jet directly against the latter. The difference of potential with respect to the earth was about 2000 volts. No notable divergence was observed from the experiments that had been made with 2000 volts in the laboratory.

The conclusions of a practical order that may be drawn from these

trials are quite important. Above all, they showed that it is practically impossible for a fireman to receive a shock from a wire at a low potential without approaching a nozzle to within about an inch of the conductor, and only in this case when the fireman holds the nozzle with one hand and an earthed conductor with the other, and is well soaked with water. As a consequence, firemen can be assured that they may throw water on live conductors without danger of shock. The shocks felt by firemen in throwing water on electric light wires of 220 volts cannot be explained except by admitting a direct contact between the pipe and the wires. The results of these experiments are consequently reassuring with respect to the supposed dangers to firemen from electric conductors, such as may be encountered in extinguishing fires.

Elements of Illumination—XXIII.

By Dr. Louis Bell.

TO determine the real illumination produced at any distance by a particular radiant, it is necessary to take the assumed height and the distribution curve to the radiant, and then to compute the illumination of that distance, using the real candle-power corresponding to the direction of the ray considered. To save labor it is convenient to plot the illumination at various distances in the form of a curve, thus enabling the illumination in candle-feet to be read directly. Fig. 1 shows a set of curves thus computed from the four types of arc lamps, of which distribution curves were shown in Fig. 3 of the last paper. The first important lesson to be drawn from them is that none of the lamps shown gives really useful illumination at a distance of more than 150 ft., and that lamps *A* and *B* should not be spaced more than 250 ft. apart if the minimum illumination is to be about 0.03 candle-foot. Lamps *C* and *D* might be spaced at 300 ft., but not much further without producing a conspicuous dark belt. *A* and *D*, the enclosed arcs, give relatively better illumination at considerable distances than the open arcs. It should be noted that the height of all lamps is assumed to be 25 ft. and that the curves begin at 50 ft. from the lamp, the space within that distance being relatively well lighted.

Comparing the several types of lamps it at once appears that for street lighting the 6.6-ampere enclosed continuous current arc is fully equal to the 9.6-ampere open arc (so-called 2000-cp), while the 6.6-ampere alternating arc is rather better than the 6.6 ampere continuous-current open arc (so-called 1200-cp), but materially less

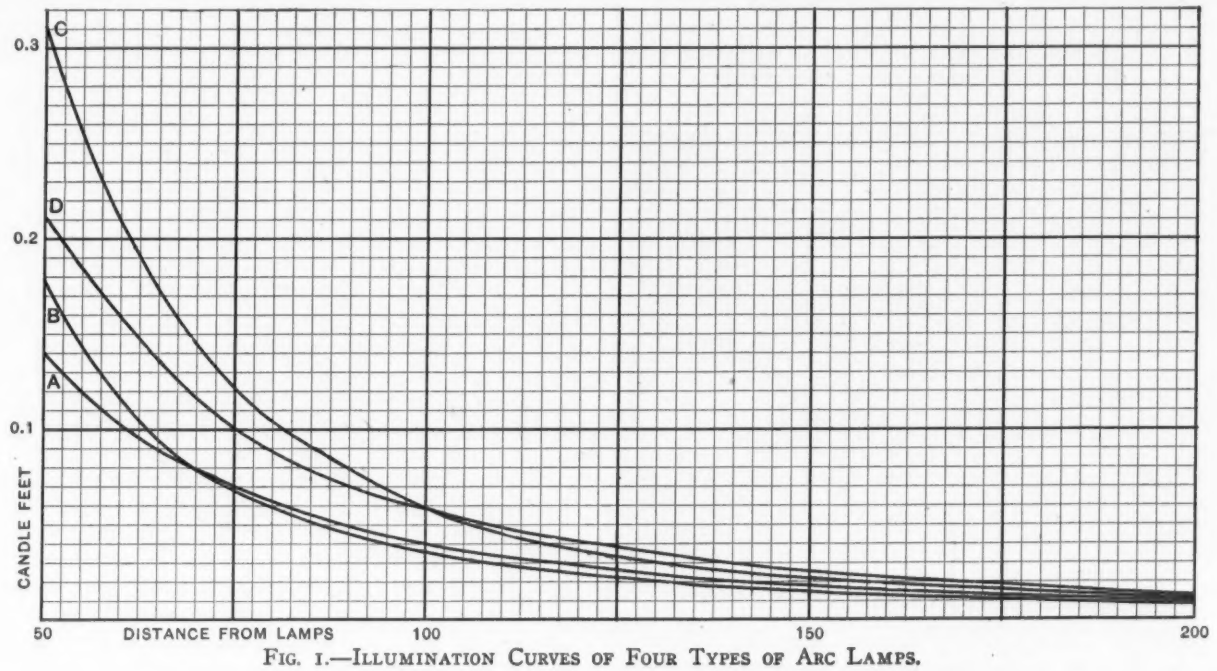


Fig. 1.—Illumination Curves of Four Types of Arc Lamps.

effective than the other two. In the author's opinion, it would correspond to a nominal 1500 cp as respects the open arcs rated in the old-fashioned way.

But theory and experience unite in indicating that effective illumination on streets is not measured exactly by the process just explained, useful though it may be. There is a physiological as well as a physical factor in illumination, for in the presence of lights of great intrinsic brilliancy the iris closes and the image on the retina grows faint, like the image in a camera when the lens is stopped down. Thus it is difficult to see beyond a brilliant light, and when the eye is exposed to the intense glare of an open arc it does not recover promptly enough in passing on to get the full value of the relatively feeble light at a distance from the lamp. This effect and the more uniform distribution of light account for the well-established fact that enclosed arcs, both for alternating and continuous currents give more satisfactory illumination than would

Fig. 2.—Illumination from an Open-Arc Lamp.

seem to be warranted by the computed intensity of the illumination. Besides the enclosed arcs are generally steadier, which tends to improve matters.

The same advantages would be secured by using open arcs with properly designed diffusing globes, but these last really require the employment of a focusing lamp in which both carbons are fed into the arc at rates proportional to their rates of consumption so as to hold the arc in a fixed position. Such lamps are more complicated and less fitted to out-door use than ordinary lamps, and have not come into use for this purpose in this country.

The advantages in uniformity of distribution and in absence of shadowed areas, gained by the use of enclosed arcs, are very conspicuous. Fig. 2 shows the illumination from an ordinary open arc, aided by a globe ground below to diffuse the light and lessen the shadows beneath the arc. In spite of this the illumination is far from uniform and the side rods of the lamp, on account of the small luminous area of the arc, throw dense lateral shadows. Fig. 3 shows the result of replacing this particular lamp by an enclosed arc. The shadows completely disappear and the more powerful rays near the horizontal are shown both by the better illumination

along the street and by the glare that evidently entered the camera. These results are very striking, and amply justify the present tendency to replace open by enclosed arcs, quite irrespective of the lessened cost of carbons and of trimming in the latter case.

Enclosed continuous-current arcs can be operated about 100 hours with one pair of carbons; in other words, they have to be trimmed only about once a week in all-night street lighting, while the ordinary open arcs require trimming daily under like circumstances. The resulting saving in labor and in carbons is variously estimated, and changes somewhat with local conditions, but the weight of evidence indicates a net saving of about $10 per year per lamp, the same energy being used in each case.

Of late a strong inclination has developed toward the use of alternating-current lamps, worked in series like the others through the aid of constant-current transformers or automatic regulators, which take the alternating current at constant voltage and deliver a current constant in amount, but varying in voltage according to the load to be carried. To discuss these interesting mechanisms in detail is without the purpose of this paper. Suffice it to say, that they do their work extremely well, although at the cost of certain inconveniences, less on the whole than those attending the use of ordinary arc generators. As already has been noted the alternating arcs demand a little more energy relatively than continuous-current arcs, but, as a rule, this loss is fully compensated by the more economical distribution of current rendered possible. The enclosed alternating arcs require slightly more expensive carbons, and rather more frequent trimming than the enclosed continuous-current arcs. As a rule, one pair of carbons will last 75 or 80 hours, and the street lamps must be trimmed once in five or six days, but a considerable saving in carbons and labor is still effected. It probably amounts in average cases to about $8 per year per lamp.

The smaller intrinsic brilliancy of enclosed arcs enables some gain to be made by placing them lower than 25 ft., perhaps no more than 18 or 20 ft., which means a still further gain in effective lighting. As between continuous current and alternating-current arcs taking the same current the former are distinctly more powerful but either at 6.6 amperes can replace the open arcs either of 1200 or 2000 nominal candle-power, lamp for lamp, and give equally satisfactory illumination. In new installations the alternating lamps may advantageously be spaced a little closer than the continuous-current enclosed arcs, as the curves of Fig. 1 indicate.

There is no question that where plenty of light is wanted in a street comparatively clear of trees, well distributed arc lights give by far the best results yet attained. But where, as in many residence streets in the smaller cities the whole roadway is well shaded by trees, arc lamps as ordinarily installed, find their usefulness greatly

FIG. 3.—ILLUMINATION FROM AN ENCLOSED-ARC LAMP.

limited by shadows. If the foliage does not come too low good results can be obtained by putting the arcs on cross suspensions over the center of the street at a height of not over 18 to 20 ft. In this case the enclosed or otherwise shaded arcs have an immense advantage, as they can thus be swung low without seriously dazzling the eyes, and throw shadows less intense than the open arcs.

But there are streets so well shaded that even arcs so placed are at a disadvantage, and there are also many cases in which there is no real need of a brilliant illumination, but merely enough light is desired to make the way fairly clear. Economy also sometimes dictates caution in the expenditures for street lighting, and in such cases incandescent electric lamps or gas lamps are capable of doing good service at comparatively moderate cost. The incandescent lamps used for such service are nearly always operated in series, either on the same circuits as arc lamps or on separate series circuits by themselves. In the former case the lamps are generally 50, 65 or 100 candle-power, made to take a constant current corresponding to that used for arcs. In the latter case the incandescents are generally of 16, 25 or 32 candle-power, worked in series upon an alternating-current circuit of 1000 or 2000 volts, taking 2 to 4 amperes. The running conditions in either case are rather severe,

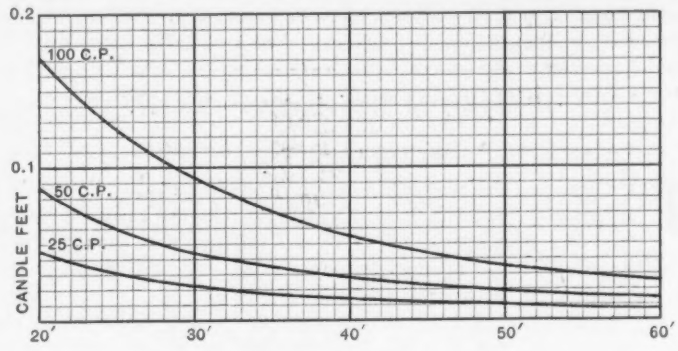


FIG. 4.—ILLUMINATION CURVES OF INCANDESCENT LAMPS.

owing to the likelihood of fluctuations in current, and incandescent lamps intended for such service are rarely of higher efficiency than 3.5 to 4 watts per candle.

In the case of gas lighting, the present tendency is to use mantle burners giving initially 50 to 100 candle-power. Their color is comparatively inoffensive in street lighting, and they can be run at very low cost, but outdoor conditions seem to tend to rapid deterioration of the mantles, so that in practice it is difficult to find a street in which most of the mantles have not long outlived their usefulness. Incandescent electric lamps deteriorate fast enough, but in street service even they hold their brilliancy much better than the mantle burners. The moral is that in using either of these illuminants a very liberal allowance should be made for falling off in candle-power.

As in the case of arcs, the illumination should be computed from the distance, height and light-distribution curve of the radiant. For incandescent lamps of 25, 50 and 100 candle-power the resulting illumination curves are shown in Fig. 4, which may be compared with Fig. 1. It is clearly evident therefrom that such lights should hardly be spaced much over 120 ft. apart, even when of 100 candle-power, while those of 50 and 25 candle-power should be spaced somewhat nearer. If they held their brilliancy well, one might space them further, but, in fact, it is undesirable. In using the above curves for mantle burners it should be noted that one such burner corresponds approximately to a 50-cp incandescent electric lamp, being somewhat better in the early stages of its life, but losing brilliancy rather rapidly.

In heavily shaded streets incandescents and mantle-burners may best be used bracketed out a few feet from the curb, with alternate lamps on opposite sides of the street. One hundred-candle-power lamps spaced in this way with 250 ft. between consecutive lamps on the same side, or even 300 ft. under favorable conditions will produce a fairly lighted street, and 50-cp lamps spaced a little closer, say, at 175 to 200 ft. on each side, will do even better, but except for use in shaded streets arcs are much to be preferred.

When close economy is an object, 25-cp lamps spaced at 150 ft. between lamps on the same curb, or mantle-burners similarly placed will give tolerable lighting, but when in suburban districts lights must be economized it is better to trust to arcs spaced even so widely as to leave regions of comparative darkness between them.

Whenever possible, lights should be so located at street corners as to shine effectively in all four directions. They should be placed preferably on long mast arms on on cross-suspensions, unless in a fairly clear street, where pole taps or short brackets are effective. One small but useful point in locating lights is as follows: Never locate a lamp, particularly an arc at the curb squarely opposite a crossing, for the shadow of one walking on the crossing plunges his way into inky blackness as soon as he has passed the light.

Squares and open spaces should be treated somewhat in the same manner as streets, but if the spaces are clear the lights may well be placed higher than in street lighting, 30 to 40 ft. being advan-

tageous. In well shaded spaces one may use lights of small intensity to considerable advantage, but ordinarily arcs do the best work. As to intensity, the lighting depends on the character of the space, but it should never be less than in a well-lighted street. Now and then such lighting drifts naturally into a species of scenic illumination, the object being to bring some fine square into brilliant relief. Occasionally in such work incandescent lamps can be massed with admirable results, although in general it is not advisable to mix arc and incandescent lighting.

The arrangement of public lights should be more or less influenced by the general illumination of the private premises along the streets. In large cities it often happens that through the evening hours when the citizens are much abroad the sidewalks are fully lighted by the stray illumination from windows. In such instances the public lighting can be well directed toward special points where it will do the most good, care being always taken to see that the illumination does not fall below minimum requirements when the batches of private lights are out. In small cities there is comparatively little aid of this sort. The most troublesome problems are those connected with the environs of such cities where miles of sparsely settled streets must be dealt with.

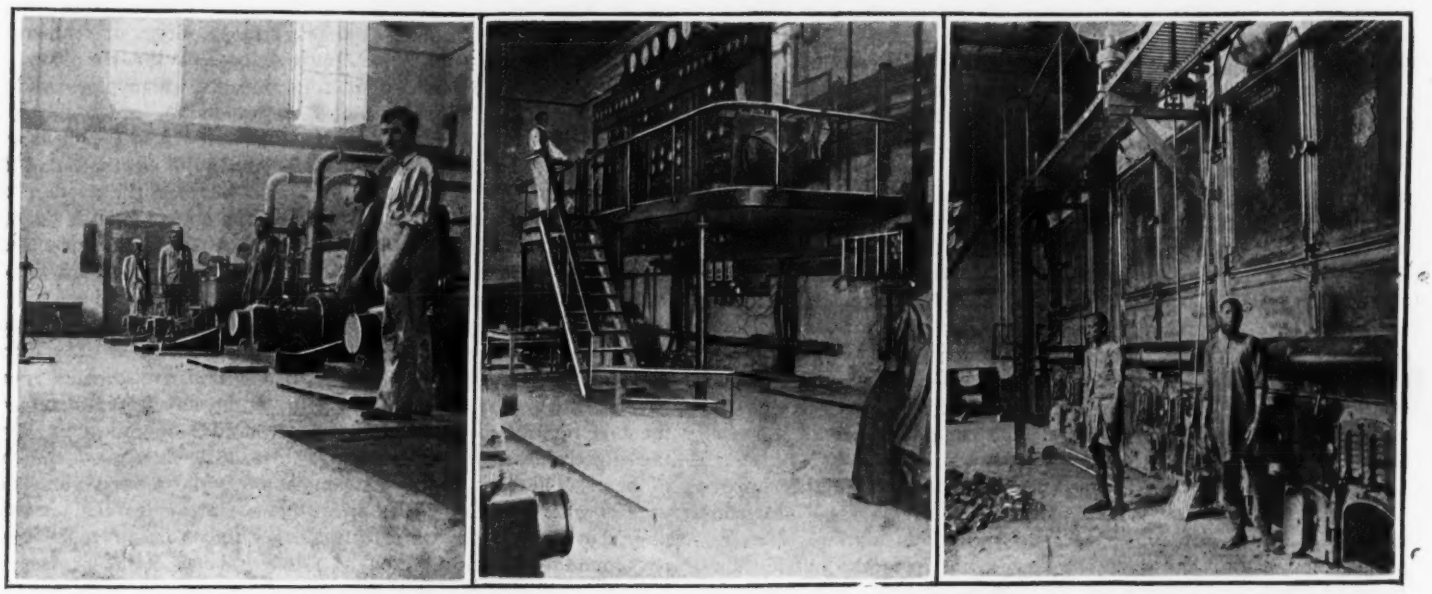
Electrical Development in India.

Considerable attention has been devoted of late to the subject of electrical development in India, and the plans now adopted for such work as the long distance transmission in Mysore, are likely to set an example for other portions of the British Empire. The larger Indian cities are taking up questions of local lighting and trolley traction, and a good market bids fair to spring up. The fact that American apparatus has been ordered for the Mysore transmission is said to be only an indication of readiness to buy apparatus here. United States Consul-General Patterson, of Calcutta, has recently made an interesting report on the subject, which is supplemented and confirmed by advies from our own correspondent.

He states that the past year has been marked by a great development of electrical enterprise in India. The largest scheme is, as noted, that at Mysore, where the waters of the Cauvery Falls are being harnessed for the benefit of the gold mines. In Calcutta, the tramways company will shortly adopt electrical traction, and will require dynamos of the same size as those ordered for Mysore; but there is no water power available in Calcutta, no one as yet having essayed to chain the mighty Hooghly. But the largest dynamos yet ordered for India are those for the Calcutta Electric Supply Corporation, whose engineer, Scott Moncrieff, has just returned from England, having arranged for the delivery of two sets of engines and dynamos, each of 1100 horse-power. The present somewhat limited plant is illustrated in the accompanying views.

As already noted by our correspondent some months ago, the electric fan, driven by current from the corporation's mains, has already acquired great popularity in Calcutta. These fans are in most cases placed 15 ft. apart. In the cathedral, which is pronounced the coolest place in Calcutta in the hot weather, they are placed ten feet apart. The central telegraph office and the high court have adopted the fifteen-foot standard, and private installations vary in their number of fans according to the ideas and pecuniary resources of the householders. The Electric Supply Corporation has introduced a system of hiring out fans at a charge of four rupees ($1.28) per month for each fan, which is likely to prove popular. The electric light is also particularly useful in India, and its widespread use in Calcutta shows how well it is appreciated.

In addition to the above instances of the use of electricity, it is announced the workshops of the East Indian Railway and of the Bengal-Nagpore Railway will shortly be driven by electricity, the shafting, belts and pulleys giving place to electric motors.



Glimpses of the Central Station, Calcutta, India.

Preparations for the Institute Conversazione.

Few recent events in electrical circles have excited so much general interest as the approaching conversazione of the American Institute of Electrical Engineers at Columbia University on April 12. A large committee is busily at work, applications are coming in briskly from members for tickets for themselves and guests, and a most interesting programme of exhibits has already been provided, although at this writing the list is not complete in all its details. Secretary Pope requests us to ask members who desire to attend to send in their requests for tickets immediately in order that due provision may be made, and that the work of the various sub-committees may be facilitated. The following members and scientists will be present and describe new and novel inventions and apparatus, perform experiments, etc. The Engineering Building of Columbia University, its museums and laboratories, will be open for inspection: Andrews, W. S., Revolving High Frequency Spark: Aluminum Cell; Baillard, E. V., Faradmeter and Bridge; Clark, C. L., Phase Indicator; Clift, A. F., Telpherage System; Crocker, F. B., Magnetic Liquids; Geyer, Wm. E., Incandescent Lamp Experiments; Donaldson, W. W., Gould Storage Battery; Hammer, W. J., Langley's Bolometer. Collection of Balloon Photographs. Nernst Lamps in Operation; Hewitt, Cooper, Vacuum Tube Lighting in Operation; Hutchison, M. R., Micro-Telephonic Apparatus for Deafness; Laws, F. A., Radiographs of A. C. Wave Forms; Louis, Otto T., Electric Furnace. Holtz Machine and Ohmmeter; Palmer, H. R., Telautograph, working between Columbia and Chicago Universities; Perret, Barrett and Meadowcroft, Storage Battery; Pupin, M. I., Original apparatus used in developing recent invention for improvement in Long-Distance Telephony; Reber, Captain Samuel, Wireless Telegraph. Army Telephone Outfit; Robinson, Wave Form Indicator and Frequency Indicator; Rice, M. P., New X-Ray Apparatus; Ryan, H. J., Radiographs of A. C. Waves; Sanville, H. F., Copper Splicing Machine; Scott, Charles F., Alternation Meter, Phase Shifting Transformer, Power Factor Indicator, etc.; Thomson, Elihu, Dynamo Static Machine, Electric Gyroscope and Bohnenberger Sphere; Townsend, Fitzhugh, Wave Tracer.

Losses of Heat from Underground Pipes.

By Alton D. Adams.

So rapid is the loss of heat from bare pipes containing hot water or steam, that their use in any extended system of underground distribution for general warming is entirely impracticable. Trials by several experimenters have shown the loss of heat from bare steam pipes to be five to six times as great per square foot as the loss from pipes of equal temperature covered with the best kinds of heat insulation to a thickness of one inch. Dry, still air is one of the poorest conductors of heat, and the best materials for insulating hot pipes owe most of their effectiveness for the purpose to the fact that they consist mostly of air confined among their fibers. This is illustrated by coverings of loose wool, feathers and mineral wool, each of which has solid matter to only about 5 per cent of its bulk. All of the heavy materials that are used for pipe insulation are comparatively ineffective, in nearly the same proportion that their weight increases. Animal and vegetable fibres, while desirable as to their insulating properties, are not generally suitable for the insulation of steam and hot-water pipes, because their structure is changed and even destroyed, together with most of their insulating properties, by long exposure to high temperatures. As the thickness of the best insulating materials on hot pipes is made greater the loss of heat is not reduced as fast as the radial depth of the coverings is increased, and a point is soon reached where the cost for additional covering is enough to offset its advantage.

A radial depth of one inch is much used for pipe coverings, but this is a smaller amount than the possible saving in heat warrants. Thus it has been found for covering of hair felt with a thickness of four inches, the loss of heat is about four-tenths, and with two inches six-tenths of the escaping heat where a covering only one inch thick is used. The less effective substances for heat insulation, show much smaller gains for an increase of thickness, as in the case of sand, which allows the escape of nearly seven-tenths as much heat when six inches as where only one inch thick. Still poorer heat insulators, such as dry clay, show a nearly constant loss of heat from pipes, whatever the radial depth from one-half inch up to six, while for solid carbon, nearly twice as much heat escapes where it is applied to a depth of six inches, as where it is only one-inch thick. Wood is a rather poor insulator of heat, and allows a comparatively large loss when it is used as a covering in contact with the pipes, its use in this way is also open to the objection that heat changes its structure and may lead to combustion. Loose calcined magnesia and mineral wool are among the best non-combustible materials for the insulation of hot pipes. A method of insulation that has been employed in a number of cases for underground heating pipes includes for each pipe a box or bored log of white pine, with an opening large enough to allow about one inch of air between the surface of the pipe and the wood all around. While it is claimed that this method of pipe insulation is very effective, there are no reports of accurate tests at hand to show just what has been accomplished with it. Quite a number of careful tests have been made to determine the losses from hot pipes with coverings of a mineral nature, of which loose calcined magnesia, light carbonate of magnesia and mineral wool are among the best examples. These coverings are usually placed in contact with the pipe surface and with a radial thickness of about one inch.

Whatever the covering used on heated pipes, it is highly important that it be kept dry, since water largely increases the heat-conducting power of any substance employed for insulation. It is especially important that water be kept away from the outside surfaces of steam and other pipes that are at or above a temperature of 212 degs. F., because the steam formed at this temperature and atmospheric pressure absorbs heat very rapidly. The losses of heat per unit of time, from a steam or hot-water pipe, whether insulated or not, depends on the difference in temperature between the pipe itself and the air or other substance outside of a bare pipe, or outside the insulation of a covered pipe. To determine the loss from any particular pipe it is therefore necessary to know the temperature of the air in the trench and that of the steam or water in the pipe. The temperature of the trench in which the pipe is laid can be only approximately determined for the average practical case, but that of the circulating steam or water is easily found at the station and on the premises of consumers. From the temperatures found for the steam or water at the last mentioned places, an average may be fairly taken for the temperature of the underground pipes. A thermometer may well be introduced at points in conduits for underground pipes, and the temperatures thus taken, but such results are subject to variations with changes in the weather, the amount of water in the soil and the degree to which the circulating water is heated or the pressure of the steam employed.

In heat distribution by water in underground pipes, the average temperature of the pipes may be as low as 150 degs. in mild weather or at some hours of the day in cold weather, while as much or more than 187 degs. when the demand for heat is at its greatest. If steam is distributed at 10-lbs. gauge pressure its temperature is 240 degs.; at 20 lbs., 259 degs.; at 50 lbs., 297 degs., and at 100-lbs. gauge, 338 degs. F. The temperature of distributed steam is much more nearly constant than that of hot water, because water falls in contained heat at the same rate that it cools, while nearly all of the heat that steam gives up is latent. Thus steam, in falling from 20-lbs. gauge pressure to that of the atmosphere, yields 15 heat units per pound, and drops in temperature from 259 to 212 degs., but on the change from steam at 212 to water at 212 degs., 966 heat units are given off per pound. A certain amount of pipe surface in an underground system of heat distribution will, therefore, usually suffer a greater loss where steam than where water is used.

It has been found that heating pipes covered to a thickness of one inch with the best insulating materials of a mineral nature, such as mineral wool and loose calcined magnesia, give off approximately 0.5 heat unit per square foot of pipe surface hourly per degree difference in temperature between the pipe and the surrounding air. For bare steam or hot-water pipes the loss of heat may easily be 2.5 units hourly per degree difference of temperature between the pipes and air, for each square foot of their surface. These figures indicate that about five times as much heat is lost from steam and hot-water pipes when bare, as when insulated with a first-class covering one inch thick. Where the quality of pipe insulation, and the temperature of the conduit in which pipes are laid, is known, the rate of loss of heat per square foot of pipe surface can be readily predicted, for any temperature of the circulating medium. Thus, with steam at 20-lbs. gauge pressure, corresponding to a temperature of 259 degs. and a temperature of 100 degs. in the pipe conduit, the loss of heat per hour from each square foot of outside surface of the pipe, when covered with one inch of first-class insulation, is $(259 - 100) .5 = 79.5$ units. At a steam pressure of 50 lbs., corresponding to 297 degs., the hourly loss of heat is $(297 - 100) .5 = 98.5$ units, and at a pressure of 100 lbs. and 338 degs. of temperature $(338 - 100) .5 = 119$ units per square foot. With the same assumption as to temperature of conduits, hot-water pipes with an average temperature of 187 degs. corresponding to conditions in very cold weather have a loss of $(187 - 100) .5 = 43.5$ heat units hourly per square foot. In comparatively mild weather, and during a part of each 24 hours, in very cold weather, the average temperature of hot-water pipes may readily be as low as 150 degs., so that the hourly loss of heat per square foot of pipe surface is only $(150 - 100) .5 = 25$ units. It should be clearly understood that the figures here given for loss of heat from pipes are based on the outside surfaces of the pipes themselves, for both bare and insulated pipes, and do not refer in any case to the surface areas of coverings. As underground pipes for steam distribution are constantly at a temperature above the boiling point of water, any water that reaches them is rapidly converted into steam, besides operating to destroy the effectiveness of their covering, since water is a good conductor of heat. The formation of steam is much the more serious cause of loss where water reaches steam pipes. Steam formed at atmospheric pressure from water at 40 degs. F. absorbs 1139 heat units per pound. The evaporation of 1 lb. of water at the surface of a pipe conveying steam at a pressure of 1 to 20 lbs., thus wastes as much heat as is lost from $(1139 \div 79.5) = 14$ square feet of the surface of such pipe hourly when well insulated. Unless pipes and their coverings can be kept dry the heat wasted by evaporation becomes so large in amount as to render paying operation impracticable.

The loss of heat per hour for each square foot of pipe surface having been established for any case, the total amount of heat escaping from the entire system of distribution may be calculated when the surface areas of all of its pipes are known. When the loss of heat from a system of pipes is determined in this way the result may be compared with those obtained by other methods, and also with the amount of heat delivered to consumers. In the case of water and steam distribution the loss of pressure should be compared with the waste of heat in the pipes to see whether their diame-

ters may be changed to advantage. For water pipes the loss of heat is readily computed when the quantity of water that completes the circuit of the system per unit of time, its temperature when leaving and on returning to the central station, and the drop of temperature while on the premises of consumers are known.

Assume a case, for example, where 1000 lbs. of hot water leave and enter a heating station per minute. Let the water start from the station with a temperature of 212 degs. and return to it with one of 162 degs., a difference of 40 degs. existing between the supply and return pipes where they enter the heated building. As the water drops from 212 to 162 degs. in temperature, each pound of it gives up almost exactly 50 heat units, so that the 1000 lbs. yield $1000 \times 50 = 50{,}000$ units of heat per minute. Since 40 degs. of the fall in the water temperature takes place in the heated buildings one-fifth of the total heat supplied is wasted by the distribution pipes. A calculated loss of heat based on the surface areas and temperature of the hot-water pipes and on the temperature of their conduit should agree with the loss found above.

When a system for the distribution of hot water is to be designed the loss of heat from the pipes cannot be determined from data covering the quantity of water moved and its fall in temperature in the several parts of the system, because this data does not exist; the loss must therefore be calculated. In order to compute the loss of heat from hot water pipes it is necessary to make certain assumptions which can easily be carried out in practice. Take for illustration, a case where water is to leave the heating station at a temperature of 212 degs., pass through outflow and return pipes where it suffers a loss of 10 degs. in temperature, and let this loss of temperature occur to the extent of 6 degs. in the outflow pipe and 4 degs. in the return pipe. It is now desired to know the fall in the temperature of the water while it is in the heated buildings, and on its return to the station. The outflow and return pipes, through which this water passes between the heating station and the heated buildings, are presumed to be laid side by side in the same conduit, so that they are of equal length and the temperature of the surrounding air is uniform for both. As the fall of temperature has been assumed to be 6 degs. in the outflow pipe, between the station and the distant end, the average temperature for this pipe is $212 - 3 = 209$ degs. The average temperature of the return pipe obviously depends for its value on the temperature of the water as it leaves the heated buildings. Let this temperature of the circulating water as it enters the return pipe be represented by X, then since the total fall of temperature in the return pipe is by assumption 4 degs. its average temperature is equal to $X - 2$. As the same amount of water passes through both the outflow and the return pipe, the heat energy lost by the water while it is in each pipe is directly proportional to the total fall of temperature therein. On the assumption of a fall of 6 degs. in the outflow pipe and 4 degs. in the return pipe, the loss of heat must be 1.5 times as great in the former as in the latter. Both the outflow and the return pipe are of equal length, diameter and outside surface, being in one conduit the temperature of the surrounding air is the same for each. It follows that the excess of the average temperature of either pipe over the temperature of the air in the conduit bears the same relation to the like excess of temperature for the other pipe, that the energy lost from the first pipe does to that from the second. It seems improbable that the temperature of the air in the conduit will ever fall below 60 degs. F. when the heating system is in operation, so this figure may be assumed in the present case.

The average temperature for the outflow pipe was found above to be 209 degs., and that for the return pipe $X - 2$ degs. The difference between the pipe and conduit temperature is thus $209 - 60 = 149$ for the outflow pipe and $X - 2 - 60$ for the return pipe. As the loss of heat from the outflow pipe is 1.5 times as great as that from the return pipe the equation $(149) = (X - 62)\ 1.5$ is established. Reducing for the value of X, $1.5X = 242$, and $X = 161.3$ degs. As X was taken to be the temperature of the circulating water when it leaves the heated buildings, and the fall of temperature in the return pipe is 4 degs., the final temperature of the water entering the station is $161.3 - 4 = 157.3$ degs. As the water leaves the station at 212 degs. its total fall in temperature is equal to $212 - 157.3 = 54.7$ degs., and since a drop of 10 degs. occurs while the water is in the outflow and return pipes, the fall of the water temperature in the heated buildings is 44.7 degs. Of the total heat given off by the water from the time it leaves the station until its return, in this case, $44.7 \div 54.7 = 81.7$ per cent, is used in the heated buildings, and 18.3 per cent lost from the distribution pipes.

The fall in the temperature of water while in buildings where the air is maintained at a given degree of heat, may obviously be varied by changing the velocity of the flow or the amount of radiating surface through which the water passes. If such changes are made there will be a corresponding variation in the relative losses of temperature for the water in the outflow and return pipes. The greater the fall in the temperature of water while in the heated buildings, the smaller is the amount of water that must be circulated per unit of time to supply a certain amount of heat. But as a large fall in the temperature of the water while in buildings implies an increase over the ordinary amount of radiating surface, a limit is soon reached beyond which a further reduction of the water temperature is not desirable. Obviously the loss of heat suffered by circulating water in distribution pipes will vary with the time it remains in them, as will also the relative loss of heat in the outflow and the return pipe. If the relative amounts of heat escaping from circulating water in the distribution pipes and in the heated buildings is not satisfactory, the velocity of the circulation, the sizes of the distribution pipes, the amount of radiating surface in heated buildings or the initial temperature of the water may be changed. When a new system for hot-water distribution is to be designed, if the assumptions first made for the relative losses of heat from the outflow and return pipes do not lead to satisfactory figures for the fall in the temperature of water while in the heated buildings, other assumptions may be made, and the fall of water temperatures for buildings again marked out.

It may be noted that the above reasoning, based on assumptions as to the initial temperature of the circulating water and on the losses of temperature in the outflow and return pipes, is entirely general as to the total amount of water sent out from the station per unit of time or the length of distribution pipes, or their diameetrs. It may therefore be desirable to illustrate the application to pipes of given length and diameter, or to a case where a certain amount of heat is to be delivered per hour. Take for this purpose the case of two seven-inch wrought iron pipes, laid side by side in one conduit from a heating station to a group of buildings one mile distant. Let the amount of heat escaping from these pipes and supplied to the buildings per minute be determined, also the velocity of circulation, for the case where the temperature of the water on leaving the station is 212 degs., or its return to the station 157.3 degs., and where there is a drop of 6 degs. in the temperature of the water while it is in the outflow pipe, and 4 degs. while in the return pipe.

Further, let the loss of heat from each square foot of pipe surface be 0.5 heat unit per hour for each degree difference in temperature between the pipe and the air of the conduit, and let the temperature of the conduit air be 60 degs. The outside circumference of a seven-inch wrought iron pipe is almost exactly 2 ft., so that a pipe of this size one mile in length has an outside surface of $5280 \times 2 = 10{,}560$ square feet. If this mile of pipe is so insulated that 0.5 heat unit is lost from each square foot of its surface hourly, for each degree difference between its temperature and that of the conduit air, the total hourly loss from the mile of pipe is $10{,}560 \times .5 = 5280$ heat units per degree of temperature difference. As the temperature of the water on entering the outflow pipe is 212 degs. and its loss therein 6 degs., the average temperature of this pipe is 209 degs., and its elevation above the temperature of the conduit $209 - 60 = 149$ degs. The loss of heat from this pipe is thus $5280 \times 149 = 786{,}720$ heat units per hour, 13,112 per minute, and 218.4 per second. Since the temperature of the water on entering the station from the return pipe is 157.3 degs. and there is a fall of 4 degs. in its temperature in this return pipe, the average temperature for the water in this pipe is $157.3 + 2 = 159.3$ degs. The air in the conduit is at 60 degs., so that the temperature elevation of the return pipe is $159.3 - 60 = 99.3$ degs., and the heat loss from it is $5280 \times 99.3 = 524{,}304$ units per hour, 8768.4 per minute and 146.1 per second. As the loss of heat per second from the outflow pipe was found above to be 218.4 units, the total heat loss from the two pipes is $218.4 + 146.1 = 364.5$ units for that time.

It was shown above, in the reasoning on the general case, that the 10 degs. of temperature lost by the circulating water while in the distribution pipes represents 18.3 per cent of the total amount of heat given off by this water from the time it leaves the heating station until its return. It follows that the total heat given off by the circulating water in this case amounts to $364.5 \div 18.3 = 1992$ units per second. As 1 lb. of water yields one heat unit in cooling 1 deg. F., to yield 1992 heat units with a fall of 54.7 degs. in the entire

heating system, the weight of water leaving and also that entering the station must equal $1992 \div 54.7 = 36.4$ lbs. per second. At 212 degs. the weight of water is 59.8 lbs. per cubic foot, so that $36.4 \div 59.8 = .609$ cubic foot must complete the circuit of the system in this case per second. The internal area of the cross-section of a standard seven-inch wrought iron pipe is 38.7 square inches, or .268 square foot. To pass .609 cubic foot of water through an opening of .268 square foot per second the velocity of flow must be $.609 \div .268 = 2.27$ ft. per second. If this velocity is not suitable, new assumptions may be made and results for another velocity calculated.

An American Smelting Plant at Ellesmere Port, England.

An interesting plant of American electrical and steam apparatus is now in use at Ellesmere Port, England, for use in the Fry smelting plant of the Smelting Corporation, Limited, for treating refractory sulphide ores. In this process the flux adopted to overcome the difficulties encountered in the smelting of ores containing zinc, is sulphate of soda and oxide of iron. With this flux, the ores after their calcination are passed through an ordinary cupola. Nearly all the lead and silver is at once obtained as bullion, and the zinc passes into the slag to be dealt with in that shape. The works are said to be the largest of their kind in England, and furnish a striking illustration of the many advantages of electric power.

The works are close to the Manchester Ship Canal, and the power plant was laid out before the smelters had been erected. It comprises two Crocker-Wheeler 400-kw direct-current generators, operating at 250 volts and direct connected to two horizontal cross-compound E. P. Allis engines, running at 100 r. p. m., with a steam pressure of 120 lbs. They are arranged as shown, side by side, with vertical Allis jet condenser placed behind the cylinders and below the level of the floor. There are six Babcock & Wilcox boilers in three batteries, with automatic stokers and forced draft furnished by two electrically driven fans. The delivery from the feed water heater is taken directly into a Hoppes purifier placed above the boilers.

The current from the generators after being taken to the switchboard is distributed to no fewer than 30 Crocker-Wheeler motors, ranging from 5 to 100 horse-power, used for a variety of purposes, such as blowing, pumping, crushing, grinding, briquetting, hoisting, driving the revolving furnaces, fans, etc., and fed, with a large number of arc and incandescent lamps, by 5 miles of main cable circuits.

In operating the plant, the ore is brought by the Ship Canal alongside the corporation's wharf, suitable for vessels of 5000 tons, and is discharged at this point by a Temperley transporter capable of discharging 60 to 80 tons per hour, worked by a 35-hp motor. The transporter delivers the ore into the crushing plant adjoining the wharf. This plant has a capacity of 90 to 100 tons a day, and is worked by a 100-hp motor. It was built by the Gates Iron Works, of Chicago, and is so fitted with elevators and transporters that the ore after being crushed is automatically moved to the ore bins adjoining. Thence the ore is hauled to the calcining department, equipped with 10 calciners of the Godfrey revolving table type. The roof of these calciners is fixed, but the floor revolves. There is an open sector in the roof where the ploughs are fixed. These ploughs stir the ore as it moves against them, and, being in the open air, are kept cool, and the oxidizing advantage of cool air is fully obtained. The grate is attached to the calciner at one side of the open sector, and the gases pass round the furnace and out at the flue on the other side of the opening, and thence to the dust chambers and big stack. The roof is low to bring the heat of the gases effectively to the ore. Each pair of calciners is driven by a 3-hp motor. After

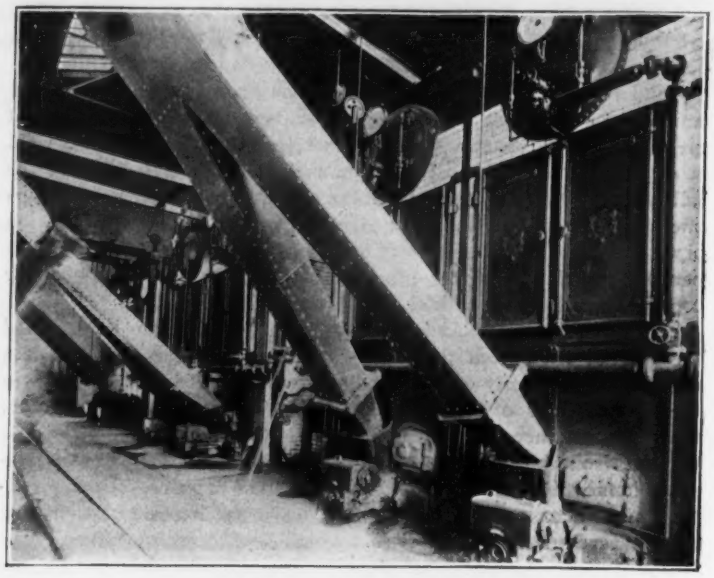


FIG. 2.—STEAM PLANT, ELLESMERE.

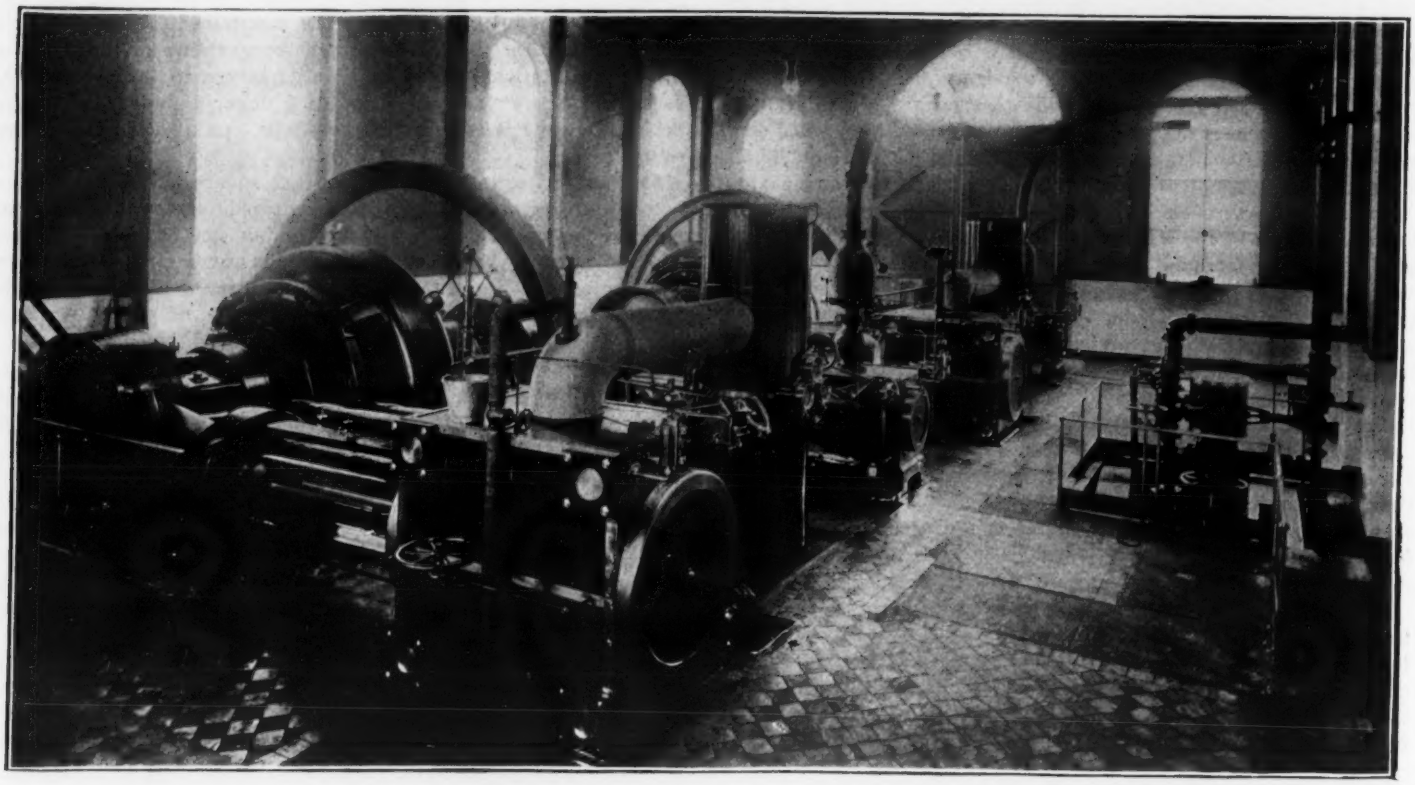


FIG. 1.—GENERATING PLANT, ELLESMERE SMELTING WORKS, ENGLAND.

calcination the ore is briquetted. The cupola is of the steel jacketed type, made by Fraser & Chalmers, of London. It is 18 ft. high and 140 in. by 42 in. at the tuyeres. At present the corporation does not desilverize the bullion that is obtained from the cupola. Slag is tapped at each end, and, after passing through settling pots, runs into the usual conical molds, and is taken thence to the zinc department. The blower is driven by a 100-hp motor. The pressure of air varies from 1½ to 1¾ lbs. More than 90 per cent of the lead and

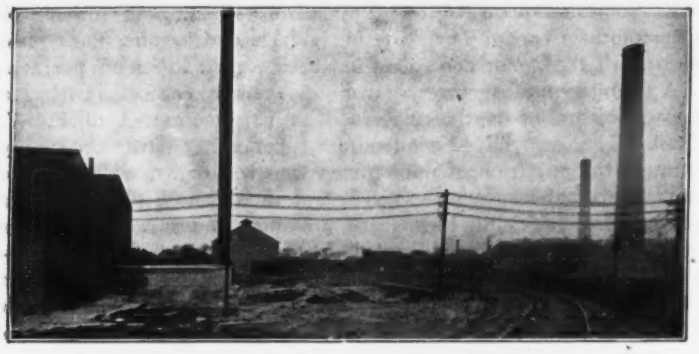


FIG. 3.—VIEW OF TRANSMISSION LINE.

80 per cent of the silver are recovered in the bullion, the remaining 20 per cent of the silver passing into the zinc slags, and being recovered in the zinc department. The slags are mixed with a small quantity of fuel, and the heat of the Siemens furnace does the rest. The oxide fumes, after passing through the regenerators, are taken through cooling towers, and then into dust flues. The flues are so arranged, that by means of baffles and pockets the dust is caught to a very considerable extent. The slag remaining in the furnace is then tapped into a large 20-ton ladle, where it settles into a heavy material called matte, and a lighter material, which is the worthless slag and is thrown away. The matte, however, which is about a quarter of the whole, is found to contain the bulk of the silver that was in the slags and any of the zinc that has not been driven off as oxide. This matte is weathered and crushed, calcined to drive off sulphur, and then mixed with the ore, briquetted and smelted. It is specially valuable as an addition to the ore, for it has, owing to its contents of iron and soda, a specially good influence in keeping the furnace open. Of the zinc entering this department, about 70 per

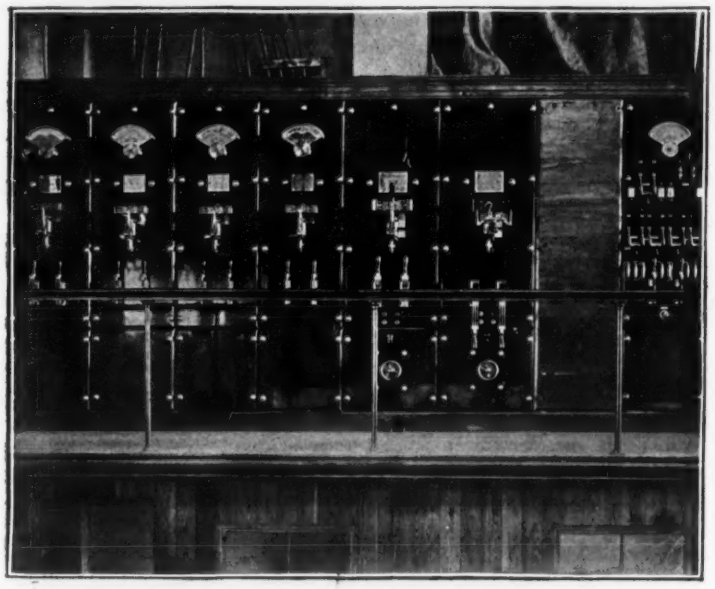


FIG. 4.—SWITCHBOARD, ELLESMERE PLANT.

cent is now being recovered, but the corporation considers that this is by no means the whole of what will be caught later on.

The corporation, in conjunction with the United Alkali Company, is working out a very interesting method of recovering the zinc from the zinc oxide by means of electrolysis.

The power plant was installed by Robert W. Blackwell & Co., Limited, whose work in the introduction of American apparatus in England and on the Continent of Europe is already well known to our readers.

Telephone Rates in Canada.

Upwards of 40 petitions from municipalities in Ontario, have been presented to the Dominion House of Commons, praying that the Bell Telephone Company be restrained from increasing the rates to subscribers. The company has given notice of application for legislation to increase its capital stock, and the bill, which was to include other provisions seeking power to advance rates, now only asks power to increase the capital stock to $10,000,000.

The company has for years persistently sought to nullify the regulation of the Dominion Parliament, which regulation prohibits any increase of the rates charged subscribers under the law of 1892. At that time the Canadian Parliament provided that the then existing rates for service should not be increased without the authority of the Railway Committee of the Privy Council of Canada. On several occasions since then, however, the company has tried to free itself from this regulation of rates, and regain its freedom of charge. The company, it is alleged, is now evading the clear intent of the law by charging higher rates for new subscribers, and municipalities throughout Ontario are, therefore, petitioning the Dominion Parliament to put a stop to this discrimination.

When the case in respect to rates was last argued before the Railway Committee, about three years ago, the company in support of its contention presented statements showing that, in 1897, its revenue was $56,147 less than the cost of operation in the city of Montreal, while Toronto showed a loss of $44,900 and Ottawa $10,000. The fact was brought out, however, that in this cost of operation there was included a large sum for plant renewal. The general financial statement also was apparently against the company's plea, for it showed that, outside the large cities, the company earned $689,000 in 1896 on an expenditure for operation of $321,000. In the company's annual statement for 1898 there were shown to be 32,082 instruments in use in Canada, the revenue being from ordinary exchanges, $935,703; long-distance service, $264,455, and from all sources, including the above, a total of $1,302,944. In the company's financial statement for last year, the instruments in use had increased to 38,360; the revenue from exchanges to $1,125,911; from long-distance lines to $359,800, and from all sources to a total of $1,614,262. The capital increase, namely, the liability to stock and bondholders, has been from $4,497,000 to $6,200,000.

It is, however, upon the figures showing operating expenses that the company's officers base their case for an increase in rates. It is claimed that the cost of operation is increasing in greater ratio than the revenue, and that under a continuance of such conditions the business must soon cease to be profitable. The cost of operation in 1898 was $897,138 on $1,302,944 of revenue, and in 1900 it was $1,146,852 on a revenue of $1,614,262, thus making an increase of operating expenses from 68.8 per cent in 1898 to 70.1 per cent in 1900. This is regarded by the opponents of the company as too trifling to warrant any increase in the rates chargeable to the telephone subscribers, and any application having that purpose in view will not, it is said, be entertained by the Canadian Parliament.

Electrical Interests in Montreal.

The bill incorporating the extensive consolidation, known as the Montreal Heat, Light & Power Company, has passed the Quebec Legislature, and has become law in that province. The company is to have a capital of $25,000,000, of which about $17,000,000 of stock will be issued. Mr. Rudolph Forget is the chief promoter of the consolidation, which includes the Chambly Manufacturing Company, the Royal Electric and the Gas companies. The Lachine Hydraulic Company is expected to be amalgamated, and the remainder of the stock may be utilized to buy out this company if deemed essential to the success of the enterprise. The net revenues of the first three companies for the past year were over $1,000,000, and as a result of the amalgamation a still more favorable showing is anticipated. Instead of 8000 horse-power from Chambly, they would have 35,000 horse-power, with an auxiliary steam power of 20,000 horse-power. The first machinery for the additional power at Chambly will be installed by April 15, and the whole completed by the middle of July. The placing of the company's wires underground would probably take three seasons, Mr. Forget says, and work has begun on the tunnel under the Lachine Canal for the Chambly wires coming into the Queen Street station at Montreal.

Recent Electric Railway Patents.

A budget of 10 patents relating to details of electric railway equipment were issued early this year, the patents in each case being assigned to the Lorain Steel Company. Following are analyses of the patents:

A patent granted to G. H. Parmelee has for an object the provision of means for preventing of improper operation of a controller of a street railway motor by ignorant and careless motormen. Such controllers usually provide a reversing and controlling spindle, and in Mr. Parmelee's invention these spindles are equipped with cams. These cams are so shaped that the operation of one spindle will drop the handle controlling the other spindle into a socket, inaccessible to the motorman, and will not be restored until the other handle has been placed in a position so to connect the circuits in such a manner that it will be proper for its mate to be operated. Thus, in an ordinary street railway controller with the reversing lever in middle position, the controlling handle will be dropped to its inaccessible socket, and will not be restored to the reach of the motorman until the reverse lever is either at the head or back position. Conversely, if the controller handle is at "on" position, the reverse lever will be dropped into an inaccessible socket and cannot be grapsed by the motorman until the controller is turned to "off." The sockets are of such shape that neither controller handle can be removed unless it is in a proper position so as to disconnect all circuits.

A patent granted to F. W. Garrett relates to means for preventing improper manipulation of controller handles, which is accomplished by a mechanical system of cams in the following way: When the controller handle is at "off," the reverse lever is raised and can be conveniently manipulated by the motorman. With the controller handle at any of the "on" positions, the reverse lever, which is flat and semi-circular in section, is hugged tightly down against the flat plate, in which position it is very difficult to manipulate.

A patent granted to F. W. Garrett and G. H. Parmelee covers an electromagnetic latch as applied to street railway controllers, and which will prevent the controller handle from being turned beyond a predetermined notch. This latch is provided with current to make it operative by making the circuit connections of the motor such that current flows through the coils of the magnet when one of them is cut out. This throws the latch and prevents the controllers from being turned to the parallel notch where undesirable circuit conditions might obtain.

A patent granted to F. A. Merrick, which seems to be quite broad, provides for a device whereby the end bearings of electric railway motors and the circular plate carrying the same, may be secured in either the upper or lower half of the railway motor as desired. This is a much used device now common to most railway motors having divided casings, and is utilized in various modified forms.

An electric fuse box is the subject of a patent granted to E. W. Stull, where the fuse wire is held under tension and the moment that it breaks due to melting, the terminals carrying it are rapidly separated by springs. The opening of the fuse box forces the spring terminals back to a convenient position for placing a new fuse.

A device for controlling electric railway motors having numerous field coils is the subject of a patent granted to B. C. Shipman. Preliminary notches connect the field coils in multiple and place them in series with the motors. Final notches connect the field coils in series and place them in multiple with the motors. The last two notches, however, have the additional feature of placing the motors themselves, which were previously in series, in parallel for the purpose of obtaining additional changes of speed. In one of the drawings is shown a mechanical interlock which prevents one handle from being moved unless the other is in a proper position for this purpose. The main object of the invention seems to be the shunt-series combination of the field coils and the series parallel connection of the armature. The patent contains 28 claims.

A patent issued to F. W. Garrett is on a method of controlling electric motors. A friction clutch on the armature is shown in a drawing to be electro-magnetic, but an additional means of control provides for changing the motors from series to parallel relation. This latter feature is important in view of the present situation with respect to motor control.

A patent granted to F. W. Garrett provides a system for governing the use of a number of controllers by a master controller. The arrangement is electromagnetic, the spindle of the controller being provided with numerous poles corresponding to the notches and which engage themselves in magnetic interlock with a stationary pole. It is plain that the controller will assume its several positions according as the various poles are provided with exciting current. The poles on the spindle are provided with a commutator in order that their notches be successively brought into position, and means are provided for automatically opening the circuit of the motors in case the current supply fails, and keeping the circuit open until the motor controller has been turned to its off position.

A similar means for controlling several controllers by a master controller is the subject of a patent granted to E. W. Stull. The controller spindles are operated electromagnetically through the provision of numerous magnetic circuits, which engage with one another when energized, and thereby lock the controller in different position. Means are provided to protect the motors from injury or failure of current from any cause. A further object of the invention is to provide means whereby the car circuit breakers may be reset from any desired point on the car, and means are provided to indicate to the motorman if any circuit on the car be open. The invention provides for a master controller and a sub-master controller. The sub-master controller has but two positions, which are fixed by the electromagnetic device already described. Resistances are used which are cut out of circuit by solenoidal switches brought successively into play. The invention also comprises a motor reverse switch, an actuator therefor and master reversing switch which controls said actuator. The invention is quite complicated and subject to many modifications within the claims.

A patent issued to F. W. Garrett is on an alarm device for armatures. This invention is intended to give timely warning when the bearings of a motor have worn, and there is danger of surface of armature striking the pole piece. As applied to railway motors, as shown in this patent, the armature strikes a contact, thereby causing appropriate lamps suitably placed to become lighted and giving due warning of the extreme decentralization of the armature axis.

New York Electrical Society at an Automobile Station.

A most interesting evening was spent by a large gathering of electrical people in this city on March 27, when, through the courtesy of the New York Electric Vehicle Transportation Company, the New York Electrical Society held its two hundred and thirteenth meeting at the new main station, Eighth avenue and Forty-ninth street. The society was welcomed by Mr. Henry Sanderson, president of the company. The meeting was held in one of the upstairs departments, where Mr. George Herbert Condict, consulting engineer of the company, mounted on an automobile as a rostrum, delivered a brief practical address on electric automobile work in New York City, and gave various details with regard to the system. Mr. Condict stated that the company now had over 300 vehicles in operation, with capacity for at least 700, whereas only four years ago it had but twelve in operation. He attributed the great success and popularity obtained to the fact that when he himself was unable to reach New York from Philadelphia for three days, owing to the blizzard of 1899, and when none of the horse vehicles could ply the streets of New York, the electric automobiles were found able to plough their way through the snow drifts with comparative ease. But for the performance of the electric automobiles on that memorable night, New York society would have been paralyzed, and, even as it was, the vehicles were busy till late the next morning, carrying home society people who had been stalled at balls, theatres and private residences. Strangely enough, the New York Electrical Society visited the old stables of the company that same night, upon which occasion Mr. Condict was to have addressed it. At the present time, the company's vehicles in this city are making a mileage of 100,000 miles a month, and as many as 900 calls a day have to be turned down, because coming in when the entire available rolling stock is already engaged. The plant was then briefly described by Mr. Condict along the lines of the illustrated article which appeared in the Electrical World and Engineer last January.

After Mr. Condict's remarks the whole of the vast building, in all its departments, was thrown open to the visitors, numbering be-

tween 300 and 400, who roamed about freely at will, watching the machinery in operation, and taking particular interest in the ingenious methods and appliances by which the batteries are taken to and from the charging room and inserted into and removed from the vehicles in service. After this examination, the Company served coffee and other refreshments, and it was not until 11 o'clock that the members dispersed, the society having scored another emphatic success in its plan of visiting electric installations, so as to enable its members to see for themselves the processes and details of operation.

President Martin announced that on April 25th, at Columbia University, Mr. Charles F. Scott, electrician of the Westinghouse Electric & Manufacturing Company, would deliver a lecture, illustrated by apparatus and experiments, on "Alternating Current Motors." Mr. Scott's well-known ability as an inventor and his gift of clear exposition will render this one of the most valuable meetings held by the society during its remarkably active and successful season, which, before it closes, will include one or two more very interesting evenings. The secretary requests us to announce that the striking lecture on "Systems of Electric Transmission and Distribution," delivered before the society by Mr. C. P. Steinmetz, has been issued in a neat and handy pamphlet, octavo size, which can now be secured from him at 120 Liberty Street, or by mail at 25 cents a copy. This is one of the best popular treatments of the alternating current now available, and requests for it are already such as to insure its wide circulation.

The following members were elected: E. H. Mullin, 1 West 102d street, New York City; J. Lloyd Wayne, engineering department, New York Telephone Company, 15 Dey street, New York City; Franklin S. Holmes, 108 Fulton street, New York City.

Rapid Transit Plans for Brooklyn.

Mr. Albert L. Johnson recently made a proposition to the committees of the Municipal Assembly to provide a rapid transit system for Brooklyn. President Orr, of the Rapid Transit Commission, stated that the Rapid Transit Board would consider the proposition if it were made in a form enabling the commission to deal with the matter. Mr. Johnson, therefore, presented the matter in definite form at the meeting of the commission on Thursday last. He stated that if his plans are adopted he will put up the $1,000,000 cash deposit required by law, and give additional bond to build and equip the tunnel and railroad at the lowest cost to the city; to wait for his reimbursement as to so much of the cost as may be in excess of the city's present constitutional debt limit, until the city can lawfully pay him; to carry passengers for three-cent fares within the city limits; to pay union wages in construction and operation, and to provide an adequate sinking fund for the cost of construction and equipment. Mr. Johnson is reported to have said in a subsequent statement that he will furnish, free of cost to the city, his own plans for a route. He will begin the route at the Jersey shore on Staten Island, at the nearest point to Philadelphia, his object being to make this as nearly as possible an air line between New York and Philadelphia. The plans, it is stated, contemplate a tunnel under the Narrows, between Brooklyn and Staten Island, and tunnel, depressed, elevated or surface construction on land, according to the topography. Besides the Brooklyn system, it is part of the proposed plan to make a connection with the New York rapid transit system, now being constructed. Mr. Johnson's proposition was, in the opinion of the Rapid Transit Board, not sufficiently definite, and President Orr was instructed to so notify him, and that the commission would not withdraw pending plans for rapid transit in Brooklyn on such "vague statements" as were contained in Mr. Johnson's letter.

Equipping the London Metropolitan Underground.

A special dispatch from London of March 28 says: "It was learned to-day that Charles T. Yerkes has obtained control of enough of the stock of the Metropolitan & District Underground Railway to prevent the installation of the Ganz high voltage alternating current (British) system. Mr. Yerkes arrived in London after the directors had adopted the Ganz system subject to the approval of the Board of Trade. The representatives appointed to interview the Board of Trade were interdicted by the influence of Mr. Yerkes. the matter is now in statu quo. The experts appointed by the London directors having pronounced in favor of the Ganz system, the matter will now be taken out of their hands, and the subject will become a question of financial negotiations between Mr. Yerkes and the London board. There is little doubt that Mr. Yerkes will succeed, his object being to establish a uniform American continuous current system on the Metropolitan line in connection with London's 'tuppenny tubes.' Mr. Yerkes and the London directors are now working for a compromise, which it is anticipated will amicably result from the daily conferences which are now being held."

With regard to this matter, we have cabled the representative of the Electrical World and Engineer in London, Mr. A. C. Shaw, and are advised by him that the contract for the Metropolitan has not yet been awarded to the Ganz Company, in spite of the statements cabled from England to that affect, and printed in many of the newspapers here.

Opposition Telephony in New York.

Although much has not been heard lately of the opposition telephone movements familiar to the New York public during the past few years, another one has cropped out to keep things lively. The name of the newcomer is the Atlantic Telephone Company. It has a capital of $5,000,000, with main office at 20 Broad Street, and the officers are W. H. Stayton, president; C. B. Reid, secretary and treasurer; D. A. Reynolds, manager. At the present time, the upper part of the city is being canvassed, and it is understood that a large number of subscribers have been secured in Harlem. The "contract" is a novel one. The installation of the apparatus will be made free of charge, and a rate of 5 cents per message will be charged. On the other hand, the subscriber has to agree that the contract shall run for five years at that rate, and must give the company exclusive telephonic use of the premises. How this would work out in case of a change of tenancy or ownership does not appear quite clear.

A citizen of Harlem who had been approached by solicitors of the new company for permission to wire buildings for the service, took the precaution, before granting the exclusive wiring rights in his property asked for, to make inquiry of the Commissioner of Public Buildings, Lighting and Supplies, regarding the status of the company. Commissioner Kearny is also generally known as Commissioner of Subways, as he takes the place of the old Board of Electrical Control, and has general supervision of all concerns running wires under, through or over the streets of the city. The Commissioner's reply was as follows: "Not to my knowledge has it any franchise to do business in the city of New York, or to build or to occupy subways; nor has it made any application for the right to erect poles and string wires within the city of New York, a formality that must be gone through with before it can do business."

The company informs us that it cannot discuss at present its plans as to exchange, apparatus, etc., and that it prefers just now to maintain silence on the subject.

In the meantime, the New York (Bell) Telephone Company has issued notice of a special Harlem rate, which is developing considerable new traffic. Service will now be supplied to subscribers connected with the Harlem exchange from the minimum of $3.25 a month. Moreover, a charge of only 5 cents a message is made on all purely local communications, of which the number increases rapidly. The rates apply to the district between 110th and 140th Streets, on Manhattan Island, from river to river.

Failure of Public Electric Automobiles in Massachusetts.

A special meeting of the stockholders of the New England Electrical Vehicle & Transportation Company will be held in Jersey City April 29 to vote upon the recommendation of the directors that the company be dissolved. A circular, which is being sent to stockholders, states that there are 223,498 shares of stock outstanding, par $10, fully paid, and 1674 subscription certificates upon which $5 per share had been paid in. The company owns, free of mortgage, the land and buildings in Boston, Mass., known as the Cyclorama building for which $163,350 was paid and the building in Newport, R. I., used for the company's station, for which $21,503 was paid. In alterations and additions to the buildings in Boston and Newport there has been expended the sum of $165,374; and for machinery and appliances necessary to the conduct of the business in the Boston and Newport stations and in the sub-stations about Boston the

sum of $156,648. Until Feb. 28, 1901, there had been expended in the purchase of vehicles and batteries the sum of $769,036.

The company had on hand on March 1, 1901, in cash $607,084 and 245 vehicles of various types. It also controls the capital stock of the Boston Transit Company, a Massachusetts corporation with a cash capital of $100,000. For the six months ending March 1, 1901, the gross income including profits on sales and exclusive of interest on deposits and rentals has been $95,310, and total expenses $211,969. The directors state that in carrying on the public carriage and delivery wagon business in Boston, in spite of every effort in economy, the expenses exceed the receipts. The reduction in operating expenses has been continuous; but "your board is of the opinion that, in view of the large outlay necessary to establish the present business and the limited scope of the same the returns confidently expected at the beginning will not be realized. They have not felt justified in paying out the cash in the treasury in the purchase of other vehicles, nor do they feel it to be for the interest of the stockholders of this company that this cash and the valuable real estate owned by the company should be longer applied to a business from which they believe under existing conditions a return cannot be obtained commensurate with the amount of capital. The company has no debts other than current liabilities. There are a number of cases pending for personal injuries; but the company is insured, and it is not believed that the damages in any case will exceed the limit named in the policy. Your board is therefore of the opinion that the interests of the stockholders will be best served by stopping operations and dissolving the corporation in the manner provided by the statutes of New Jersey, by converting the assets as promptly as possible into cash, and distributing the same ratably among the stockholders."

The Electric Vehicle Company will agree to a cancellation of the contracts between the two companies.

A French Manufacturer on Edison and Tesla.

Mr. Edison's efforts to separate magnetic iron ore economically appears to have attracted no little attention in Europe recently, although they have been familiar for some years to the American public, which has watched with no little sympathetic interest his unceasing hard work in that direction. The following dispatch from London of March 3 bears on the subject: The *World* correspondent interviewed Eugene Schneider, head of the Creusot Iron Works, the most important rail, locomotive and gun factory in France, about Thomas Edison's new claim that he has discovered a process which will blast America's steel supremacy. This process has created great excitement here and in England lately, because if Mr. Edison could really separate hematite from magnetite, converting the former into Bessemer steel, enormous European ore deposits now unprofitable would yield richly. Mr. Schneider and his chief mining engineer expressed themselves skeptically regarding the new discovery. Mr. Schneider said: "What is the use of discussing Edison's advertising dreams? He has no special knowledge of metallurgy, and the problems he claims to have solved have engrossed scientists all over the world. Let Edison occasionally do what he claims he can do and then we will be willing to give him attention. But Edison's tactics, like Tesla's, consist of finding what difficulty puzzles scientists and announcing that their own genius is about to solve it. But when the time comes neither realizes his glowing promises.

"Let it be said once and for all that real scientists all over the world consider Edison and Tesla a pair of humbugs. What has Edison discovered except the phonograph, which was a chance discovery and not the result of scientific perspicacity. Not electrical incandescence, for that was really invented in Germany, nor the biograph, which was discovered here by Lumiere, nor anything of real importance.

"On the other hand, has Tesla destroyed the Spanish fleet, as promised, or telephoned across the ocean, or lighted houses without wires, or entered into communication with the planet Mars? It is a perfect wonder that the American public, with its quick sense of humor, has not long ago shamed these two cheeky pretenders into silence."

This dramatic outburst on Mr. Schneider's part is to be explained perhaps by the following special cable dispatch of the same date: Joseph Lawrence, chairman of the Linotype Company, Sheriff of London and head of the British syndicate comprising 55 ironmasters, which acquired the Dunderland iron deposits in Norway, containing 80,000,000 tons of ore, speaking to the *World* correspondent respecting the statement that his syndicate would counterblast J. P. Morgan's, said: "Seeing that we purchased the property 18 months ago, you can judge how far it was a calculated attempt to countervail the European operations of the Morgan syndicate, though in the event that it promises to work effectually in that direction by the application of Edison's new crushing and magnetic extraction processes, our property in Dunderland promises to provide, under English control, a supply of high-grade Bessemer ore adequate to the needs of Great Britain for many years to come."

Manufacturing Exports from the United States.

Exports of iron and steel manufactures from the United States continue to increase. An analysis of the February report figures has just been completed by the Treasury Bureau of Statistics, and it shows that the total for the eight months ending with February, 1901, is six and a half millions in excess of the unparalleled figures of last year, and nearly three times the total for the eight months ending with February, 1891, thus showing an increase of 10 per cent in a single year and 333 per cent in the decade. In the eight months ending with February, 1891, iron and steel formed but 3 per cent of the total domestic exports from the United States; in the eight months just ended they form 8 per cent, being $81,553,132—against $75,053,768 in the corresponding months of the fiscal year 1900, and $18,823,384 in the same months of 1891.

Not only is the total larger in the aggregate, but it covers a greater diversity of products, thus showing that the manufacturers of the United States are not only increasing their output, but each year fabricating a larger proportion of their product and thereby securing for themselves and the labor employed thereon a greater share of the profits accruing from such manufacture. A decade ago such articles as typewriters, bicycles, electrical machinery, cash registers, laundry machinery, pumps and pumping machinery, shoe machinery, and other articles involving a high degree of manufacture, had no place in the export schedules of the United States. Now they constitute an important part of our annual exportations of iron and steel, and are steadily increasing both in volume and in the number of foreign markets in which they find profitable sales. In 1891 no exports of electrical machinery were recorded, but by 1900 the figures for eight months' transactions had reached about $2,500,000, and for the eight months ending with February, this year, amounted to $3,777,673, an increase of $1,345,000 in a single year. Exports of steel rails increased from $395,484 in the eight months ending with February, 1891, to $4,818,226 in the corresponding months of the fiscal year 1900, and $6,889,079 in the same months of the fiscal year 1901. Scales and balances have increased in export value over 50 per cent during the decade; locomotives over 200 per cent, printing presses over 300 per cent, and builders' hardware over 300 per cent. Every item in the entire iron schedule shows a substantial increase in 1901 as compared with 1891, but in a few instances there are decreases as compared with 1900, presumably due to the advanced prices consequent upon the increased cost of material.

The area of distribution steadily and rapidly enlarges. In builders' hardware, for instance, the exports now go not only to the principal countries of Europe, but to Mexico, Central and South America and the West Indies, British East Indies, China, Japan, Australasia, Africa, and the Islands of Oceania. Sewing machines and typewriters find a market in the most distant inslands, and the demand from the European and the other leading countries is increasing, while the demand for electrical machinery is growing in every direction.

	Eight months ending	
	Feb., 1891.	Feb., 1901.
Total iron and steel	$18,823,384	$81,553,132
Steel rails	395,484	6,889,079
Builders' hardware	1,353,848	6,053,126
Electrical machinery	Not stated.	3,777,673
Locomotive engines	837,308	2,828,156
Steel bars	Not stated.	2,637,813
Structural iron and steel	Not stated.	2,296,287
Wire	534,530	2,499,946
Pumps and pumping machinery	Not stated.	1,497,136

The above table shows the exports of some manufactures in eight months ending with February, 1901, compared with the eight months ending February, 1891.

French Trade in Electrical Machinery.

From the official statistical returns for the year 1900, just published by the French Government, we gather that France imported during that year dynamo-mechanical machinery to the value of 11,963,250 francs, as against 6,018,473 francs in 1899, and 3,740,562 francs in 1898. Parts of electrical machinery were imported to the value of 4,348,160 francs, as compared with 2,080,760 and 1,569,651 francs in 1899 and 1898, respectively. The imports of electric accumulators represented a value of 64,650 francs in 1900, as against 101,859 francs in 1899 and 136,691 francs in 1898. Incandescent lamps were imported to the value of 480,000 francs in 1900, 506,440 francs in 1899, and 479,040 francs in 1898. It will be seen from these figures that the total imports of electrical machinery and incandescent lamps amounted in value to

16,856,060 francs in 1900,
8,597,532 francs in 1899,
5,926,004 francs in 1898.

The great increase in the imports of 1900 is largely to be traced to the great demand for machinery created by the Exposition. The exports of electric machinery from France are relatively small. The principal figures for 1900 and 1899 and 1898 are as follows: Dynamo machinery, francs, 1,647,720, 2,074,754 and 1,434,873; parts of electrical machinery, francs, 2,079,000, 1,991,736 and 2,250,315. The statistics above referred to are but a résumé of the foreign trade of France and details on the exports and imports as to the countries of origin, etc., are not yet available.

Telephonic Development at Pittsburg.

The present telephone situation in Pittsburg is peculiar and presents phases that appear problematical; withal, however, it is interesting. There are three live companies there and two silent or retired companies that may be rejuvenated at any moment; and all five have franchises well worth fighting under. Of the three live companies the Bell is naturally the largest and most strongly intrenched. In its Pittsburg exchange district, comprising practically all of Allegheny County, and which includes the cities of Pittsburg, Allegheny and McKeesport, 40 boroughs, 44 towns and villages, and about 20 railroad stations, it lists nearly 16,000 subscribers. Then it has as many more subscribers in the remainder of its territory in the State.

Next to the Bell is the Pittsburg & Allegheny Telephone Company, the new independent company promoted by Baltimore capitalists. It claims that 2000 telephones are now connected to its switchboard in Pittsburg and about 500 connected to its exchange in Allegheny. At the present writing, it has no service outside these two cities, but expects soon to have toll-line connections with the home exchanges in Braddock, Homestead, Wilkinsburg and Verona. The rumor is again prevalent that this property will soon pass into the hands of the Federal Telephone Company, an event that will be heralded with satisfaction by all the subscribers to the new service who desire out-of-town connections.

Third in order of prominence comes the Federal Telephone Company, an organization that has been most vigorously fought on every hand from the day of its formation to the present time, but which appears as fresh as a daisy after every battle. The Bell Company fought it bitterly and found itself outclassed. The Pittsburg & Allegheny Company did all in its power to crush the Federal, filling the daily papers with stories about its being a Bell ally, and even going so far as to try to induce Judge Thomas to use the power of the National Association to exterminate the Federal. Yet the P. & A. employees are now said to be questioning how many days will elapse before they will be on Federal pay rolls.

The Federal Company paralleled the Bell's main trunk line along the Beaver road on the north bank of the Ohio, beginning at the city limits of Allegheny and running to Rochester, in Beaver County, a distance of 25 miles. It did likewise along the Monongahela River from McKeesport to Brownsville, a distance of 44 miles. In the 18 months that have elapsed since its organization, the Federal Company has secured franchises and completed its lines in 42 boroughs and connected nearly all by toll lines. In addition, it has purchased nearly a score of companies, all of which, save one, have been absorbed by the Federal Company, and it has applied for franchises in 47 boroughs. Thus, should it succeed in purchasing the Pittsburg & Allegheny Telephone Company, it could have 100 cities, towns and villages connected to the Pittsburg exchange within 30 days from the date it assumed control.

Without these out-of-town connections, there can be no true competition in Pittsburg. For there is no longer any value in merely local service. It must include all the towns in the same county at least. The Federal Company can give these out-of-town connections, but can give no Pittsburg service. The P. & A. can give a limited Pittsburg and Allegheny service, but no out-of-town connections. The rational procedure would be a consolidation of interests or a working agreement, but the P. & A. refuses to enter into either one. As the Federal has invested more than a half million dollars, it must have a Pittsburg connection in order to preserve the integrity of its investment, even if it purchase one at an exorbitant price. Of course, it can build under its own franchise rights, but to do so under existing circumstances would necessitate a local investment of more than $500 per telephone. That is, to install 13,000 telephones in Pittsburg (the number required to successfully compete with the Bell Company) would require an investment of about $7,000,000, owing to the fact that few if any pole lines could be used, an ordinance being in force in this city, which makes it prohibitive for more than two pole lines being constructed on one street. What will be the outcome of the present telephone entanglement in Pittsburg it is difficult to predict just now, but the developments promise to be very interesting.

Buffalo Automobile Endurance Test.

At a recent meeting of the executive committee of the National Association of Automobile Manufacturers, the endurance test of the Automobile Club of America, to be run next September from New York City to Buffalo, was fully discussed, and the following resolutions were adopted:

Whereas, It has been brought to our attention by both the press and members of the association, that the Automobile Club of America is contemplating giving an endurance contest of automobiles from New York to Buffalo next fall; and

Whereas, The manufacturers deem that they are largely interested in the contest and feel that suggestions from them in regard to the proper conduct of such a contest would not be objectionable to the Automobile Club of America; therefore, be it

Resolved, That the executive committee of the National Association of Automobile Manufacturers convey to the Automobile Club of America the resolution passed by this committee, putting forth their views as to the proper management of the run.

The resolution mentioned above is as follows:

Whereas, The National Association of Automobile Manufacturers, having discussed fully among themselves the proposed endurance contest of the Automobile Club of America, next fall, and having come to definite conclusions as to their opinions regarding the proper conduct of such run; it is

Resolved, That the National Association of Automobile Manufacturers believe that the basis for judging the said contest should be average speed of miles per hour; that each vehicle should be required to maintain a certain average speed per hour for each morning's run and the same average speed per hour for each afternoon's run. In other words, a vehicle must maintain a certain average speed from control to control. Judges shall be placed at each control, and the records of each vehicle taken. Each vehicle that maintains the average speed required by the club from each control to control for the entire distance shall be considered to have made a perfect run, and will be entitled to a certificate of first award of honor, from the Automobile Club of America. Every vehicle that maintains an average speed that may be fixed for the second class shall be entitled to a certificate, stating that they were in the second class, and performed the trip at an average speed of so many miles per hour. Every vehicle that maintains an average speed that may be fixed for the third class shall be entitled to a certificate of the third class, stating that they maintained a certain average speed per hour.

Classes: We recommend that the vehicles be divided by weight into four classes—A, B, C, D. Class A, vehicles of four wheels under 1000 pounds; class B, vehicles of four wheels from 1000 to 2000 pounds; class C, vehicles weighing 2000 pounds and over; class D, motor cycles, motor tricycles and motor quadricycles.

In counting the average speeds above required, each vehicle can stop as many times as desired between controls for any purpose whatever. No manufacturer or individual to be allowed to enter more than three vehicles in each class.

Development of Electric Car Lighting and Refrigeration.

For some time past there has been talk of bringing to the front in practical shape the new car refrigerating system which has been in the hands of the allied interest, and this plan it would appear is now to be carried out in the proposed purchase of the stock of the Consolidated Railway Electric Lighting & Equipment Company by the Consolidated Railway Lighting & Refrigerating Company. The circular issued by President Isaac L. Rice to the stockholders of the Consolidated Equipment Company states that the system of refrigeration to be adopted is greatly superior to the old system owned by the equipment company, and claims that its acquisition will add very largely to the company's earning capacity. Mr. Rice says:

"In my effort to secure control of this system for the Consolidated Equipment Company I was met by the objection that the owners of the patents were not willing to sell their rights for stock unless a suitable working capital, aside from that of the Consolidated Equipment Company used for its lighting purposes, would be provided. There being no means of providing such working capital on the part of the Consolidated Equipment Company without another large issue of stock, owing to the present market price of the stock of that company, the only method remaining was for the holders of the patent to organize a new company, reserving sufficient amount of shares in their treasury for such working capital which was ready to be underwritten, but permitting the stockholders of the Consolidated Equipment Company to obtain the corresponding interest in the shares of that company upon the condition of furnishing such working capital. After numerous consultations the following plan was therefore agreed upon between the owner of the Refrigerating Company patents and a number of leading stockholders of the Consolidated Equipment Company.

"A company to be organized, which would issue a total of $4,600,000 of its stock to acquire the refrigerating patents, and also, incidentally, the patents of the Safety Third Rail Company, which is controlled by the same interests, both companies requiring machines, etc., that could be profitably manufactured by the Equipment Company at their plant at Derby, Conn.; $16,000,000 to be issued in exchange, share for share, for the present stock of the Equipment Company upon the payment of $2 per share by such stockholders for the working capital of the refrigerating business; that is to say, the new company will have a total capital of $22,000,000, of which $16,000,000 will be issued to acquire the shares of the Consolidated Equipment Company and $4,600,000 to acquire the following:

"Four million eight hundred thousand dollars of the total of $6,000,000 of the Refrigerating Company; $5,400,000 of the $10,000,000 of the Safety Third Rail Company, and $3,000,000 of the $5,000,000 of the European Refrigerating Company, leaving $1,400,000 of the stock in the treasury for the further uses of the company.

"By means of this arrangement the stockholders of the Equipment Company will retain all their previous rights and all the profits of the Equipment Company, the affairs of which look extremely promising at the present day, and in addition will acquire the control of the chloride of ethyl refrigerating process, as well as the control of the safety third rail, and, in my opinion, therefore, bring the dividend period on their stock decidedly nearer.

"The books of the Equipment Company show to-day a surplus of over $600,000; and, if all the stockholders unite in this exchange, the new company, by ownership of such stock, will show a surplus of nearly $1,000,000, which would be ample to carry out all the plans of the company and do sufficient business to put the new company on a dividend basis.

"The relations which the Equipment Company has formed with Messrs. Vickers, Sons & Maxim, Limited, in England, will, in my opinion, be still further improved and cemented by the acquisition of the refrigerating business on the part of the stockholders of that company through the instrumentality of the new corporation, which will, I believe, give the European business of the company a very considerable impetus.

"I desire to impress upon the stockholders that this arrangement which I have succeeded in making is purely an option secured for them, and that they will not in any way prejudice their present position by declining to avail themselves thereof. The two companies are not at all competing, as the refrigerating company controls no lighting patents; while the methods of refrigeration controlled by it, being much simpler and more practical, of necessity preclude competition on part of the Equipment Company for refrigeration business, whether the shareholders of the two companies become identical or remain distinct."

CURRENT NEWS AND NOTES.

ANGLO-GERMAN CABLE.—The work of laying a new cable line between Emden, Province of Hanover, Prussia, and Bacton, County of Norfolk, England, has been begun. This will be the seventeenth Anglo-German cable line laid.

AUTOMOBILE SLEIGH.—Consul-General Guenther, at Frankfort, Germany, reports the appearance at Nuremberg of an automobile sleigh. He states that the vehicle moves with considerable speed and with easy motion, but gives no details as to motive power or mechanism.

A LONG TRIP ON AN AUTOMOBILE.—A dispatch from Cannes, France, March 27, states that M. Hinde, a member of the Automobile Club, recently made a trip in a 12-hp. automobile from Frankfort-on-the-Main to Cannes, a distance of 708 miles, which was covered in forty-four and one-half hours. The dispatch further states that severe weather was encountered during the trip, and frequently the vehicle was axle-deep in snow. The route was by the way of Switzerland and the lower Alps.

STORAGE BATTERY BOOSTER SYSTEM.—In the application of the storage battery to electric railway work boosters are often employed to cause a battery to discharge and co-operate with the main generator during periods of more than average load, and to charge during periods of less than average load. A patent granted March 26 to J. B. Entz has for its object to make the booster in such cases act promptly and thus to increase the efficiency of the regulation. It is customary to provide such boosters with a separately excited or shunted field coil, but a departure from the average load tends to produce in this coil a change of current opposing the magnetic effect desired to be produced in the field of the booster, and thus delaying the regulation sought to be accomplished. To obviate this defect there is inserted in the above mentioned circuit an impedance coil, this coil constituting a resistance of high self-induction which also tends to resist the above mentioned changes of current in the circuit.

ELECTRICAL HEATING RESISTANCE.—In many heating tools a very high temperature is required, and hitherto the application of electric heating to such tools has not been possible for two reasons—first, because the ohmic resistance of the compounds hitherto employed has been found to decrease rapidly as the temperature was raised; and, second, because the combinations used rapidly deteriorate and finally fall to pieces. The principal causes to which these difficulties are ascribable are that the various powders used to dilute the carbon have always formed carbides with the same when subjected to very high temperatures, and that the reduction in volume which occurs when such compounds are frequently subjected to high temperatures and the relaxation of pressure in part due to this contraction, finally deprive the frail resistance of necessary support. In a patent granted March 26 to Wm. S. Hadaway, Jr., a compound is described which is claimed to obviate the above defects. This compound is composed of an intimate mixture of finely powdered carbon, preferably graphite, and finely powdered crystalline magnesia oxide united by any of the proper binding cements. In preparing the compound ordinary magnesia is subjected to the action of an electric furnace in order to change its form to a crystalline mass of maximum density on cooling. The graphite is very finally powdered and then thoroughly baked at a high temperature, which may be the same temperature as that to which the magnesia is subjected in fusion; the two powders are then thoroughly mixed. It has been found that a mixture of 10 per cent of graphite and 90 per cent of magnesia is suitable for use with 110 volts where a temperature of about 900 F. is required. The mixture so produced is molded into the required shape with molasses water and then after baking is ready for use.

WIRELESS TELEGRAPHY IN SPAIN.—The Administration of Posts and Telegraphs contemplates the introduction of wireless telegraphy in Spain on a large scale. It is rumored that Marconi will soon go to Madrid to arrange matters with the Government. The Balearic and Canary Islands are first to be connected by this system, which will then be extended from these islands to the Continent. Several places on the coast of Morocco, such as Ceuta, etc., will be connected with Algeciras and Tarifa.

A NEW COHERER.—It has recently been established that the harder the metal particles are which are used in a coherer, the greater is the accuracy in breaking contact; it has also been established that this function of the metal depends even in a higher degree on the hardness of the electrodes together with their corresponding capacity for being highly polished, than on the hardness of the metal filings used. In a patent issued March 26 to Adolph Koepsel, Charlottenburg, Germany, a coherer is described, in which the electrodes have their effective or acting surfaces made of hardened steel or hardened cast iron, the filings interposed between the same being of steel.

PHILIPPINE CABLE TOLLS.—The estimated cost to the Government of cable tolls on the messages between Washington and the Philippine Islands is $1,000 a day. The House Committee on Interstate and Foreign Commerce, when considering a bill for the construction of an American cable between San Francisco and the Philippines, was not able to get this important datum with any precision. Representatives Sherman and Corliss succeeded in learning that the War Department alone had spent as much as $365,000 a year. This did not include the messages of the State Department or the Navy Department, or the private mesages sent and received by the President from the "war room" in the White House. This subject assumes importance because of the proposals before Congress looking toward a Pacific cable, owned and operated by the United States. Nothing was done at the last session, but the subject is sure to be revived.

THE FIRST ELECTRIC TRAMWAY IN BULGARIA.—On the 29th of January last the first electric street railway of Bulgaria was opened at Sofia, the capital of the country, after the city had been equipped with an electric light system a few months before. The French engineer, Bertolus, who had been granted a concession for 40 years for the light and tramway plants, succeeded in utilizing the fall of the Isker River for the generation of the required amount of electric power. A tunnel, some 4600 ft. in length, was built and the fall of 105 ft. thus obtained, produces 3000 horse-power. Bertolus ceded his concession for the light plant to the "Société de Grand Travaux," of Marseilles, and that for the tramway to the "Trust Franco-Belge des Tramways de Sophia." The Marseilles company is said to have invested 4,000,000 francs, and the Trust 3,500,000 francs in the enterprise. The city of Sofia receives light at the low rate of 18 centimes (3.474 cents) per kilowatt-hour. The tramway has a length of about 12½ miles. Cars, dynamo machines and turbines were imported from Belgium; steam engines and underground cables chiefly from Germany, which country also supplied a certain number of cars; rails came from the United States and copper cables for the tramway from France.

IMPROVEMENT IN DIRECT-CURRENT DYNAMOS.—In direct-current machines whose armature field is neutralized by means of an opposite field of the same strength, such as when the Ryan system is employed, and also in rotary converters where no armature reaction exists, it is nevertheless necessary to shift the brushes on the commutator from the neutral zone in order to attain a commutation free from sparking, and this shifting of brushes gives rise to a reaction of the armature and an undesirable variation of voltage. In a patent issued March 26 to Max Déri, of Vienna, Austria, a method of magnet winding is described which renders it possible to attain in these classes of machines a commutation without sparking with a fixed position of the brushes, while at the same time drop of voltage is prevented or the armature voltage may be varied in any desired manner. A special compensation winding is provided on the field magnets, through which the main current passes and gives rise to a field that combines with the main field to produce a resultant of the necessary intensity and position. The required conditions of this arrangement are as follows: First, that there shall exist no armature field, or but a very weak one; second, that the main field and the compensating field shall develop and combine as uniformly as possible, preferably in sine form, this being effected by arranging the field magnet all around and equidistant from the armature; and, third, the main field shall be excited with uniform strength (shunt-wound machine). As illustrated, the field consists of a ring completely surrounding the armature and having no salient poles. The winding of the shunt and series field is such that the two fields produced are at an angle to each other, and produce a resultant field variable in strength and position, according to the value of the main current, whereby one component effects sparkless commutation, while the other component effects the regulation of the pressure. On the field magnet opposite the armature coil short-circuited by the brushes a closed winding is provided, consisting of one or more convolutions, which oppose a resistance to the rapidly changing flux in the short-circuited section.

ELECTRO-CHEMICAL PRINTING.—A patent was issued March 26 to William Friese-Greene, London, England, on an electro-chemical printing process intended to replace the ordinary process of typographic printing and printing on textile fabrics, and to dispose of the uses of inks or colors and enable the ordinary printed fabric to be replaced by a cheaper and more durable one. The process is based upon a discovery that with a material impregnated or incorporated with an oxygen derivative of benzine which will reduce a haloid salt of silver, and traversed by an electric current in the presence of slight moisture, an exact reproduction of the electrical conductor in contact therewith is instantaneously produced; such reproduction being independent of the material of which the conductor consists and of the direction of the current. In typographic printing the type form is connected to the negative pole of the circuit, since type or printing plates are made of an attackable metal which is destroyed if connected to the positive pole. In carrying out the process the paper, textile, fabric or other surface is coated or impregnated with a photographic developer such as amidol, ametol, or hydroquinon. In practice it is found that amidol may be added to the paper pulp. The prepared paper or fabric is placed upon or caused to travel over a conducting surface, with an interposed layer of more or less moist material, such as cloth or blotting paper, the conducting surface being connected with the positive pole of a direct-current source of electricity. With the paper or fabric are brought in contact the words, figures, designs or the like to be produced, these being connected with the other pole of the circuit. An ordinary stereotype or electrotype plate is used in ordinary printing. The electric circuit being closed, the current will pass through the prepared paper and at once reproduce thereon a clear black or color fac-simile of that which is in contact, the color depending upon the particular substance employed in the paper. The reproduction can be effected, for example, by feeding sheets of paper prepared in succession as in ordinary printing by means of a platen or other machine that prints on the flat; or the reproduction can be effected by a machine like an ordinary cylindrical printing press, in which case the prepared paper can be run from a reel. In practice it is found that direct current of 4 amperes at a voltage of 100 is sufficient. The inventor states that he has been able to electrically print 25,000 pamphlets per hour by adapting the invention to a printing machine. The specifications give full details of the adaptation of the process to a cylindrical printing machine and to a flat printing machine. The claims are on the disposition of the parts in printing, and on the use of a paper or material impregnated with a photographic developer which is an oxy derivative of benzine, and which will reduce a haloid salt of silver.

LETTER TO THE EDITORS.

Alternating-Current Arc Periodic Curves.

To the Editors of Electrical World and Engineer:

Sirs:—Referring to a letter of Mr. Wiler in your issue of Feb. 16, I wish to express to him my regret if my remarks in your issue of Feb. 2 appeared unduly personal in their bearing, for it was far from my thought to make them so. I fear I may have been the cause of Mr. Wiler expending some valuable time in seeking for anticipations of my paper of 1893 on alternating-current curves, which could have been spared him had I stated that according to my invariable custom, all prior work was duly referred to and discussed

in the said paper, and that the very important articles of Heubech and Steinmetz were unfortunately anticipated by my own publication on the same subject in *La Lumiere Electrique* of April 26, 1892, page 136. Moreover, upon reading the papers quoted, I was struck by the paucity of the information conveyed and the contradictory statements contained, and this is what led to my undertaking a complete and an entirely independent study of the question of periodic curves. Such curves as those of Tobey and Walbridge are entirely misleading, as I showed in my paper.

If Mr. Wiler would do me the favor of reading the article referred to in *La Lumiere Electrique,* I hope that the opinions he has expressed would be modified, unless indeed he feels more competent to deal with the subject than those who have studied it during the last decade. I am much indebted to him for his kindly wishes relating to the oscillograph, and hope that the instrument will eventually be as helpful to him and to the electrical profession in the United States as it has been to myself and to Mr. Duddell.

PARIS, FRANCE. A. BLONDEL.

DIGEST OF CURRENT ELECTRICAL LITERATURE.

DYNAMOS, MOTORS AND TRANSFORMERS.

REFERENCE.

Transformer Efficiency.—BOEHM-RAFFAY.—A theoretical investigation of the question of how the iron losses and the copper losses in a transformer must be proportioned to obtain high efficiency. At a given load the efficiency is a maximum if the iron losses are equal to the copper losses. If a transformer is to be used in general at full load, as in sub-stations, the iron losses should be made equal to the copper losses. If a transformer is to be used, in general, underloaded, the iron losses should be smaller than the copper losses at full load. The iron losses must be the smaller, the smaller the number of hours during which the transformer is loaded.—*Elek. Neu. Anz.,* March 1.

LIGHTS AND LIGHTING.

Nernst Lamp.—An illustrated description of a method of gradually inserting into the circuit of the mains an incandescent rod which is a bad conductor at low temperatures, as in the Nernst lamp. In the first moment only a very small length of the filament is connected to the circuit. When this has become a good conductor, the length of the connected part is increased. This is done automatically by means of a sliding contact, which is operated by a solenoid in series, so that when the current increases the contact slides further and increases the length of the part of the filament which is connected to the circuit.—*Zeit. f. Beleucht.,* Feb. 28.

Boron and Silicium Filaments.—BLONDEL.—An article in which it is suggested to use boron or silicium wires as filaments of incandescent lamps. A homogeneous filament can be made, the specific resistance of which may be a hundred times that of a carbon filament. Its fusibility is not very different from that of carbon. The methods of making such filaments are discussed.—*Zeit. f. Beleucht,* March 10.

REFERENCES.

Arc Lamps.—An illustrated article on open and enclosed arc lamps of the General Electric Company, of Berlin.—*L'Elec.,* Feb. 16.

Train Lighting.—DICK.—A long and detailed description of the Dick system of electric train lighting, as applied for lighting single cars.—*Zeit. f. Elek.,* Feb. 17, 24; March 3, 10.

POWER

Factory Drive.—HOLDING.—A comparison between electrical and mechanical transmission. He gives the results of tests in three factories with belt transmission. In one, which is called a fairly average factory, the average load is 166 horse-power, the friction load 78 horse-power, the average useful energy 88 horse-power, the efficiency at average load 53 per cent. He gives curves for the efficiency of electric transmission. They show the better efficiency of the electric system. Tests in a factory of a total capacity of 300 horse-power gave a net efficiency of 70.7 per cent, while from the curves a full-load efficiency of 74 per cent is found. In the actual plant large quantities of shafting had been retained. He points out the well-known other advantages of electric transmission. He recommends the recording of energy delivered to separate departments in the factory. When each department has charged to it pro rata the cost of power, the item of factory expense no longer remains a general charge, but is an item chargeable directly to the cost of the manufactured article. This will not only facilitate the determination of the factory cost of the article manufactured, but will enable the detection of sources of excessive expense, and consequently suggest the points where improvements can be made. The record will also indicate the presence of faults in shafting, pulleys, etc.—*Rose Tech.,* March.

Electricity in Coal Mining.—IRWIN.—An article on the use of electric power in mines, especially in Western Pennsylvania fields. In the Windber mine, of the Queen Coal Company, formerly eight mules and eight drivers were required to haul 200 tons daily, at a cost of 10 cents a ton, while now two electric locomotives bring out 1000 tons daily at a cost of less than 1 cent a ton.—*Min. and Met'y,* March 15.

REFERENCES.

Electrically-Driven Pumps.—An illustrated article on the electrical driving of pumps, with large numerical tables for practical purposes.—*Elek. Anz.,* March 3, 7.

Electric Driving of Looms.—The first parts of an illustrated article, giving mechanical details of electrically-driven weaving looms, installed by the General Electric Company, of Berlin.—*Elek. Anz.,* March 17.

TRACTION.

Mono-Rail Electric Traction.—Some editorial notes on a lecture by Behr on the high-speed mono-rail road between Manchester and Liverpool, proposed by him. A speed of 110 miles per hour is proposed. Braking at such high speed is a serious question. Behr expects to be able to stop a train, in case of dire emergency, within 500 yards. He relies, however, mostly on the extreme improbability of this emergency ever arising. The perfected character of the railway and the elaborate system of signalling, contribute to this high degree of safety. By a development of the electric interlock and block system of signalling, the rear of every train is covered by danger signals for a distance of 14 miles, and on appoaching the first signal guarding this danger limit two alarms, one electrical and the other mechanical, are automatically rung in the driver's cabin, and continue to ring until stopped by him. The normal acceleration at starting is well within the limits of comfort to passengers, the full speed of 110 miles per hour being attained in 1¾ miles from the start. Centrifugal acceleration in pasing round a curve must also be carefully kept within limits. "The mono-rail principle is one that is eminently adapted to high-speed electric railways, and, even for this consideration alone, it may be expected to meet with considerable acceptance by railway promoters and engineers in the immediate future. Certainly the Manchester-Liverpool scheme ought to have a fair trial."—Lond. *Elec.,* March 15.

Electric Railways.—CARDEW.—A note on the first of his Cantor lectures on this subject. He attaches great importance to the separate excitation of motors on locomotives or motor cars. One of the advanatges of this is the possibility of returning kinetic and downgrade energy to the line, instead of wasting it by brakes. A system of electric traction which he will describe later, is said to return no less than 66 per cent of the energy to the line, owing to the use of separate excitation in regulating the motors.—Lond. *Elec.,* March 15. A longer abstract of this lecture begins in Lond. *Elec. Eng.,* March 15.

REFERENCES.

Automobile Wagon.—An illustrated description of the electric automobile wagon of the Say refinery in Paris for transportation between the works and the railroad depots. The battery consists of

84 Phœnix cells, weighing 5000 lbs., and giving 50-kw hours.—*L'Elec.*, Feb. 16.

Conduit System.—An article in which the weak points of the proposed London County Council conduit are criticized.—Lond. *Elec. Rev.*, March 15.

Installations, Systems and Appliances.

Birkenhead.—A description of the Birkenhead lighting and traction plants. For lighting the three-wire system with 460 volts between the outers is used. There are one 225, two 150-kw and three 50-kw dynamos. The three larger machines generate at 460 volts, and the three smaller ones at 230 volts, to balance the three-wire system. Two miles off, on the boundaries of the borough, a battery sub-station has been erected to serve outlying townships. It contains a 600 ampere-hour battery and motor-driven boosters. The cells are charged in the daytime and discharged at night, the load being entirely a residential one. An electric tramway line of 2½ miles has recently been opened in quite a different direction, with a small station at about the center point of the line. It contains two 150-kw, four-pole over-compound direct-driven units, each being fitted with a switch for adjusting the amount of compounding if desired. The feature of the station is a compound "reversible booster." This machine carries further the principle of the reversible boosters in use at St. Helens, as it can be used with compound-wound instead of shunt dynamos, thus keeping the feeder pressure at its correct value automatically. During the hours of light load the machine boosts up the pressure of the accumulators so that they can supply the line, and subsequently it acts in the reverse direction, adding volts to enable the batteries to be charged from the switchboard bus-bars, and to take up at the same time the peaks of the load. The machine has given absolute satisfaction since it has been running. The battery is made up of 240 cells, with a capacity of 630 ampere-hours at a 7-hour discharge rate, and the use of the booster renders regulating cells and their connections unnecessary. —Lond. *Elec.*, March 15.

Trafford.—The first part of an illustrated description of the Trafford Park power plant. This is the first electrical station to be worked in England with the special object of supplying power in bulk to large manufacturers. In the design of the works a new combination of a steam plant with a gas-producer is used. A gas-producer plant has been laid down with the special object of providing a gaseous fuel for boilers. This gas-producer is of the Mond type.—Lond. *Elec. Eng.*, March 15.

Petersborough.—An illustrated description of this new British municipal plant. The three-wire direct-current system with 460 volts between the outers is used. There are two 60-kw steam dynamos, and also a booster and a balancing set, consisting of two multipolar dynamos as balancers, coupled directly to two bipolar dynamos used as boosters. There are also two batteries with a capacity of 325 or 240 ampere-hours, when discharging at the rate of 36 or 60 amperes, respectively.—Lond. *Elec.*, March 15.

Wires, Wiring and Conduits.

Insulation on Cables.—O'Gorman.—The first part of a very long abstract of a paper read before the Brit. Inst. of Elec. Eng., on light and power cables. He urges that purely scientific experimental researches ought to be made to find a new dielectric. Electrolytes should be avoided and dielectrics should be confined to chemically inactive organic compounds, or non-electrolytes, whose class distinction is non-conductivity, and, that they exert a normal osmotic pressure. He thinks that rubber makers sin in this particular way by using electrolytic salts in their compounding. A test for disruptive strength on small thicknesses, proves nothing about a large thickness of the same material, because a diminishing dielectric strength with increasing thickness is apparently inherent in most insulators. The best way to test a dielectric is on a length of cable. The area of surface of insulator under strain in a length of cable, is enormously greater than in the case of a slab. The contact between metal and dielectric is more thorough, the curve of stress is totally different, the cable material will necessarily have to be beat about and handled, and, most important, the average value of the insulator, bubbles and all, is tried, instead of a single selected square decimeter. Bubbles are a great enemy of permanency, and tend to a loss of energy. The reason for objecting to bubbles is not only that the possibility of a single bubble increases the thickness of the dielectric throughout and thus adds to the cost of the cable, but even the increased thickness is not as effective as the thinner dielectric if the insulator were continuous. It is usual to make rubber cables with the latter grade material next to the pure rubber, because a higher test is gotten in this way with less of the high-grade material; but unless the specific capacity of the high and low grade is properly adjusted or made to be the same, which it usually is not, the disruptive strength of the finished cable will suffer under alternating pressures. He suggests the same "grading" for a method of adjusting the specific capacity, dielectric strength and conductivity of the covering of a cable, so that the materials composing it occupy the best possible positions, whether for resisting puncture or diminishing the energy loss in the insulation. He discusses three methods. The first is to make the dielectric strength of the insulation in each layer proportional to the stress or voltage gradient in that layer. This may be done by multiplying the number of layers so as to utilize skin resistance or by using special materials for the inner or highly stressed layers of high strength, like mica, gutta percha, etc., but only a small improvement is possible in that way. The second and third methods of diminishing the thickness of insulation consist in utilizing the apparently objectionable qualities of conductivity and specific inductive capacity and adjusting or grading them in each layer of the covering of the cable. If the specific conductivity of the inner layers of the insulation is made greater than the average, the difference of voltage between the two sides of each of these layers is reduced; in fact, the specific conductivity of all the layers may be so adjusted that the fall of potential in each of them is a minimum and is uniform. If the insulation of the cable is paper and resin oil, the conductivity of the inner layers is easily lowered 50 or 100 per cent, as required by the curve of gradients, by adding to the impregnating fluid used on the layers a very small percentage of linseed oil, which has no appreciable effect on the disruptive strength, and is too small in quantity to effect any practical alteration in the specific capacity of the layers "graded" by its use. This method loses value because of the large effect of small impurities and because of the temperature coefficients of the oils. The paper is to be continued. It is discussed in an editorial.—Lond. *Elec.*, March 15. The discussion which followed is abstracted in *Lightning*, March 14, and Lond. *Elec. Rev.*, March 15.

Aluminum Conductors.—A note stating that a beginning is being made in the introduction of aluminum conductors in European transmission plants. For the electric power transmission in the Pompei Valley, near Naples, aluminum wires are used throughout. The plant contains three 100-kw, three-phase generators; current at 3600 volts is transmitted to three different places by aluminum lines. These lines have a length of 1.8, 9 and 2 miles, respectively. —*Elek. Neu. Anz.*, March 1.

Electro-Physics and Magnetism.

Lecture Experiments with a Braun Cathode Tube.—Simon and Reich.—An illustrated description of suitable arrangements for a series of lecture experiments with a Braun cathode tube. The magnetic deflection of the cathode rays in this tube is used for current measurements, demonstration of alternating curves and of curves due to interrupters, for demonstrating and investigating the phase difference between current and e. m. f., the action of a Graetz valve cell in an alternating-current circuit, Lissajous figures, the rotation of a rotary field, hysteresis curves, and oscillating discharges. The following interesting experiment is also described. Two coils are used on two arms, one perpendicular, the other horizontal. The horizontal coil contains an iron rod of 1 meter length, so that the coil may be displaced on this rod. In the vertical coil there is a shorter iron rod. When the alternating current passes through both coils in series, the light spot in the Braun cathode tube describes a straight line declined by 45 degs. against the horizontal line. When the coil is displaced on the horizontal iron rod, the light spot describes an ellipse, which proves that the phase difference between the magnetic deflections increases when the coil is removed from the tube. Braun thinks that the magnetism needs a certain time to be propagated from the coil through the iron to the cathode tube. An interesting application of this apparent velocity of propagation of magnetism, is the generation of a rotary field by means of a single-phase current. Braun bends at one end of a solid iron rod of 8 mm diameter a semi-circular hook of 7 cm diameter. A coil is put around the rod, and a Braun cathode tube is so arranged that it is grasped by the semi-circular hook. When a single-phase alternating current is sent through the coil, the light spot in the cathode tube describes a circle which is the sign of a rotary field.

This rotary field is due to the superposition of the field generated by the coil and of the field due to the eddy currents in the iron. The eddy current magnetizes the iron as it would be magnetized by a coil placed upon the hook. The eddy currents have a phase difference of 90 degs. against the exciting current, so that a rotary field results. Braun has designed a meter based upon this principle. —*Phys. Zeit.*, Feb. 9.

Oscillator for Stationary Electrical Waves.—BERNOUILLI.—An article in which he recommends the Blondlot-Coolidge oscillator. By the help of this apparatus the nodes and loops of stationary electrical waves can be shown on wires which are not in a vacuum, but in the open air. This apparatus has also the advantage of enabling one to isolate, measure, and, if desired, photograph several of the overtones as well as the fundamental. The Hertz oscillator plates are replaced by two semi-circular conductors, which terminate at one end in small brass spheres, and are connected with the secondary terminals of a high frequency coil. The sparks which give rise to the electrical oscillations pass between the two brass spheres. A second spark-gap serves to increase the intensity of the oscillations. Both spark-gaps can be very delicately adjusted by means of insulated screws. Directly beneath this primary circuit of the insulator, and insulated from it by means of a sheet of mica, is a secondary circuit. This latter consists of a wire bent into a circle of the same radius as the primary circuit, its ends terminating in binding screws, and corresponds to the condenser plates of Hertz's apparatus. The vessel in which the two circuits are fastened is filled with kerosene. The copper wires, of 0.1 mm diameter, are held at one end by those screws, and at the other end by an insulated stand. If the apparatus is set in operation and the spark-gaps are properly adjusted, the wires become highly luminous throughout their entire length; and if, by bridges properly placed on the wires, stationary waves are allowed to form, the wires at the nodes for a length of a few centimeters become invisible, while the other positions, and especially those half way between the nodes, remain luminous. The phenomenon recalls the dust figures in the Kundt tube.—Lond. *Elec.*, March 8.

Dielectrics.—VON HOOR.—A very long, illustrated account of a series of experiments. He found that the dielectric constant is not independent of the polarizing e. m. f., but varies between rather wide limits; therefore the electrostatic induction and hence also the charge of the condensers which he has investigated, is not a linear function of the polarizing e. m. f. The induction curves, found by him, have the same character as the well-known magnetic induction curves of nickel and iron, which proves the analogy between the conditions of magnetic and electrostatic polarization.—*Elek. Zeit.*, Feb. 21, 28, March 7.

Secondary Radio-Activity.—BECQUEREL.—A description of the following experiment. A leaden block 34 mm long, 31 mm wide and 7 mm high, had a groove 1 mm deep cut along its upper surface, and filled wtih a radium preparation of great activity. The block was placed on a sensitive plate for 48 hours, and the latter was then developed. A strong impression was found to have been made, in spite of the fact that the rays had to penetrate from 6 mm to 20 mm of lead. A peculiarity noticed by him was that a strong geometrical impression was created where the lower surface of the lead block had rested upon the plate, and that this impression was not eliminated by inserting a plate of mica. Small plates of any metal laid within reach of the rays, instead of weakening the impression by absorption, actually strengthened it by virtue of the secondary radio-activity produced, more especially at the edges directly exposed to the rays. Such secondary Becquerel rays have, however, very little penetrative power.—*Comptes Rendus*, Feb. 18, abstracted in Lond. *Elec.*, March 15.

REFERENCES.

Radio-Activity.—BECQUEREL.—A summary of the results of the newer researches on "the radio-activity of matter."—*Nature*, reprinted in *Elec. Rev.*, March 13.

Circular Magnetization.—TROWBRIDGE and ADAMS.—An account of an experimental research on the intensity of magnetization produced by an oscillatory current in an iron wire and on the magnetic permeability.—*Am. Jour. of Sc.*, March.

ELECTRO-CHEMISTRY AND BATTERIES.

Theory of the Storage Battery.—KENDRICK.—A summary of the work of Dolezalek on this subject. The sulphate theory of Gladstone and Tribe assumes the consumption of sulphuric acid during discharge for the formation of sulphate of lead, and the formation of sulphuric acid during charge. The changes of concentration of the acid in the proportion indicated by the chemical formula of this theory, have been directly determined by experiment. Whether the action indicated by the formula is direct and primary, or results indirectly and is therefore secondary, cannot be determined from the experiments. For this a study of the e. m. f. must be made. Dolezalek gives three different methods of calculating the e. m. f. and compares the results with measurements. The first is based on the formula of Helmholtz. When the acid has a density of 1.044, the temperature coefficient of the cell is zero, and Thomson's rule is strictly correct, from it and from the known heat-tonings of the chemical processes, 1.88 volts is found in agreement with the measurements. The e. m. f. of the cell changes with the concentration of the acid. This is used by Dolezalek for the following experiment: He takes two storage cells with acid of different densities, joins them in series, but positive against positive. When this battery works, there results a change of concentration of the acid, due to the formation of sulphate in one and reduction of sulphate in the other, and the corresponding changes in the amount of the solids, lead, peroxide of lead and lead sulphate. The change of free energy, however, is involved only in the changes of concentration produced in the acid, since the solid substances are in the same condition before and after any action of the cell. This is like the deposit of copper on a copper electrode and solution of copper electrode in a copper sulphate solution. The energy involved in the concentration change can be calculated in two ways: First, by the heat of dilution involved, second, by the thermodynamic process of distillation of water from one acid to the other. This gives two independent methods for reckoning the same value. The agreement of the calculations with measurements is remarkably good. Nernst's osmotic theory of e. m. f. gives another entirely independent method of calculating the e. m. f., and the agreement with the measurements is also very good. The reversible, electro-chemical process, assumed by the sulphation theory, appears therefore to have been proved as thoroughly correct.—*Rose Tech.*, March.

Electro-Silvered vs. Plain Copper Plates in Gold Milling.—HALSE.—An abstract of a paper in which he shows that electro-silvered plates are highly advantageous, at least for a certain class of ore, and that such plates not only catch more gold in proportion than plain copper plates working under similar conditions, but that such gold is of an increased fineness. Although their first cost is very high in comparison with that of plain copper plates, they soon pay for themselves in economy of labor alone, as they require much less attention than the latter.—Lond. *Elec.*, March 15.

REFERENCES.

Edison Storage Battery.—An illustrated abstract of an English patent to Edison, dated Nov. 20, 1900. A translation of practically the entire abstract is given in another column of this issue.—*Centralblatt f. Accum.*, March 15.

Solvay Electrolytic Alkali Cell.—J. B. C. KERSHAW.—An illustrated description of this improved form of mercury cell, operated in two plants in Belgium and Russia for the production of caustic alkalies and bleach. The Solvay cell differs from the usual form of mercury cell in the absence of any mechanical movements for bringing about the desired circulation of the metal.—Lond. *Elec.*, March 15.

Graphical Treatment of the Action of Cells.—WEBER-SAHLI.—A long illustrated article on tests of primary and secondary cells, and on the graphical representation of the results in curves. The article seems to contain nothing new.—*Schweiz. Blaetter. f. Elek.*, March 8.

Electrolytic Bleaching.—BROCHET.—An article on the industrial manufacture of hydrochlorides. Brief descriptions are given of the processes of Hermite, Corbin, Kellner, Haas and Oettel.—*Elektrochem. Zeit.*, March.

Electro-Chemistry in 1900.—KRUEGER.—Continuations of his review, giving brief references to theoretical researches, published in 1900 in electro-chemistry; also on progress in primary and secondary cells, auxiliary apparatus and in electrolysis; also in electro-metallurgy and electric plating.—*Electrochem. Zeit.*, Feb., March.

UNITS. MEASUREMENTS AND INSTRUMENTS.

Alternating-Current Wattmeter.—DRYSDALE.—A long illustrated article on the theory and use of the alternating-current wattmeter. He discusses at some length the errors to which it is liable and the corrections which must be applied. He gives the following rules for the construction of wattmeters. The self-induction and capacity

of the shunt circuit should be small in comparison with its resistance. In order to measure a power-factor correctly to an accuracy of 0.001 on a 100-volt circuit, the resistance R in ohms must be at least 628,000 times the self-induction in henrys; the capacity error is KRp, where $p = 2n$ times the frequency, hence for the capacity error to be only 0.001, the capacity in farads must not be greater than $0.001 \div Rp$. To fulfill the first of these conditions the control of the wattmeter must be small. Deflectional pivoted wattmeters, therefore, as those of the Weston type, cannot be accurate at low power-factors, since the pivot friction requires considerable control, and hence great self-induction. To avoid capacity errors, the non-inductive resistance should be split into a number of separate bobbins. As the effect of capacity is opposite to that of self-induction, both of these quantities might be comparatively large if balanced against one another. This has often been done or proposed, but he is strongly of the opinion that as it is easily done, each error should be separately eliminated for accurate work. The balancing of the errors looks much easier on paper than in practice. Where, however, a fairly accurate instrument is required for general use, a suitable condenser may be used to shunt the non-inductive resistance. Mutual induction between the series and shunt coils, should be avoided. This is always the case when the coils are at right angles and the readings are taken, not by deflections, but by a torsion head. Eddy currents should be avoided by getting rid of all metal near the coils, even screws and brass cases should never be used.—Lond. *Elec.*, March 15.

REFERENCES.

Phase Meters.—Armagnat.—His paper in full, on industrial phasemeters read before the Internat. Soc. of Elec. in Paris, an abstract of which was noticed in the Digest, Jan. 26.—*Bull. de la Soc. Int. des Elec.*, Dec.

Magnetic Measurements.—Montpellier and Aliamet.—The first part of an article on industrial magnetic measurements. In this part they give general remarks on magnetic tests.—*L'Elec.*, March 9.

Telegraphy, Telephony and Signals.

Wireless Telegraphy.—Braun.—A summary of two lectures recently held by him, in which he discusses the advantages of his system of wireless telegraphy over that of Marconi. The main difference is in the transmitter. Condensers with a capacity of about the order of the usual Leyden jars were charged singly or in combination, to a high potential, and their discharges through appropriately dimensioned self-inductions were used to feed the transmitter directly or indirectly. It is evident that slower oscillations than those of Hertz are here used. He calls special attention to his "inductive excitation of the transmitter." It is characterized by the fact that the transmitter is left quite sparkless, and that the oscillations are excited in it by induction. The condensers discharge through a primary circuit, and this excites the oscillations in the lower spirally-wound end of the transmitter. The lower end of the latter remains insulated from earth. The advantages of his connections are said to be the following: In the primary circuit a large amount of energy can be employed usefully. The action of the transmitter increases with the energy employed by a much greater extent than with the Marconi connections, and can be augmented by increasing the capacity of the condensers as well as by increasing the potential. This is proved by a series of experiments. The oscillations of the transmitter are hardly active physiologically, in spite of their high potential, and a danger from unintentional contact is therefore quite excluded. Less attention need be paid to the insulation of the transmitter than in the case of electro-static excitation. The oscillations of the primary condenser circuit are slightly damped. They excite in the sparkless transmitter waves which are still less damped. If, therefore, both are brought to resonance, they increase in the latter case to a very high amplitude. Thus they fulfill the fundamental conditions necessary for electrical tuning between a transmitting and receiving apparatus; the region of useful rays of oscillations will at the same time be extraordinarily extended, as is particularly desirable for this purpose. Experiments in the open air have demonstrated a superiority over the Marconi transmitter under all conditions. The distance attainable should be, from the present facts and material, two and a half to three times that by the Marconi transmitter. To increase the receiver effects, he concentrates the energy on the receiving apparatus, so that the latter benefits by it, as far as possible, exclusively. He showed by experiments that the electric waves which pass the receiver can be concentrated 20 times or more. He also showed in his lectures the sharpness of the tuning. "Very slight changes in the tuning immediately diminished the localized energy very considerably. As the energy only collects in the tuned parts, the other parts will refuse to act, and thus the problem of the so-called multiplex telegraphy is solved in a very complete manner."—Lond. *Elec.*, March 15.

Telegraph Wires on Snow.—Brunhes.—The fact that snow is a good insulator, has been practically recognized by the employees of the Puy de Dome Observatory for a number of years. The double line which connects the observatory with the station of Rabanesse is often interrupted during the winter season. The breakage is due to the fact that the poles, covered with a layer of hoar frost, "which can attain a diameter of 3 ft.," offer too large a surface to the winds, which blow with great violence. It often happened that in the execution of repairs the workmen drew a line of wire across the snow so that the wire was in contact with the snow over a length of 30 or 40 yards. Even when the poles remained standing, it often happened that their tops were covered with snow, and that as much as 1000 yards of wire were in immediate contact with it, without the messages being disturbed on that account.—*Comptes Rendus*, Feb 25; abstracted in Lond. *Elec.*, March 15.

Subterranean Telegraph Cable.—An article on the underground telegraph cable of the Brit. Postal Tel. Dept. between London and Birmingham, a distance of 117½ miles. This is said to be the longest underground telegraph cable in the world. The cable consists of 76 wires, each of which is insulated in specially desiccated paper, and the whole enclosed in a leaden sheath to prevent the admission of moisture. It is laid in cast iron socket pipes, built in sections of 150 yards each.—*Sc. Am.*, March 16.

REFERENCES.

Theory of Wireless Telegraphy.—Abraham.—An article in which he gives a theory of wireless telegraphy, based upon Maxwell's electrodynamic equations. He gives the formulas for the damping of electric oscillations. His conclusions are in agreement with those of Slaby.—*Phys. Zeit.*, March 2.

Telegraphy and Telephony.—A summary of progress and inventions made in telegraphy and telephony from October to December, 1900.—*Elek. Anz.*, Feb. 24, 28.

Cleveland.—A long illustrated description of the Cuyahoga Telephone Company's exchange system in Cleveland.—*West. Elec.*, March 23.

Telegraphy.—A continuation of the illustrated serial on modern telegraphy. Descriptions are given of the Breguet, Morse, Hughes and Baudot apparatus, which are generally used in France.—*Cosmos*, March 9.

Rowland Telegraph.—Robichon.—A continuation of the illustrated description of the Rowland telegraph. This part deals with the reception of the signals, synchronism and the transmission of the signals.—*Jour. Tel.*, Feb. 25.

Multiplex Telegraphy.—Luginbuehl.—An illustrated article on a system of quadruplex telegraphy for a line having a branch, and on the use of the Baudot apparatus in connection with such a system.—*Jour. Tel.*, Feb. 25.

Railway Signals.—Ledrouant.—A detailed description of the Timmis-Lavezzari system of electric railway signals, which was shown at the Exposition.—*La Nature*, March 2.

Signals.—Dary.—An illustrated description of the apparatus of Siemens & Halske for transmitting signals electrically, especially on board of battleships. Direct current is used. The apparatus is of the "revolving magnetic field" type, which was described before in the Digest.—*L'Elec.*, Jan. 26.

Miscellaneous.

Effect of Invisible Rays Upon the Eye.—The impression produced by Becqueral, Röntgen and ultra-violet rays upon the human eye might possibly be utilized in the case of blindness. Rays which penetrate opaque bodies may reach an optical nerve cut off from the outer world by turbid humors or integuments. A long series of experiments in this matter has been made, but practically useful results are much interfered with by the rapid "fatigue" of the eye. After a few exchanges the subject is unable to say which of two packets, one filled with sand and the other with a radium preparation, contains the active element, though at first the latter produces a general luminosity in the eye. It appears certain that none of these

rays produce fluorescence in the human eye, though they do in the eyes of some animals. Also that it is the rods and not the cones of the retina that are chiefly affected. Geometrical impressions may be temporarily created in a blind eye by means of Röntgen rays transmitted through lead plates in which patterns are cut. A radium preparation produces a luminous sensation which appears to proceed from the side on which the preparation is held. This is a hitherto unexplained effect.—*Ann. der Physik*, No. 3; abstracted in Lond. *Elec.*, March 15.

Electric Furnace.—A brief illustrated article on a process of Machalske for the production of yellow phosphorus from phosphate rock, by means of the intense heat of an electric arc in the electric furnace; also on another process for the production of chlorides of carbon in the electric furnace. If in a furnace a mixture composed of salt, carbon and sand is treated, and the vapors are condensed, there is obtained carbon tetra-chloride, a colorless liquid of a pleasant odor, which is thought may find an extensive application in the extraction of oils, greases, etc.—*Sc. Am.*, March 23. See ELECTRICAL WORLD AND ENGINEER, March 2.

REFERENCES.

Filipino Electrical Machinery.—MAYSE.—An illustrated article on electrical machinery made in workshops in the Philippine Islands, which is said to answer all practical purposes, although the finish is imperfect. The demand for electrical machinery is, however, far in excess of that supplied by the native builders.—*West. Elec.*, March 23.

Paris Exposition.—HAUSEGGER.—Continuations and the conclusion of his very long, detailed and well illustrated article on the exhibits of Ganz & Co.—*Zeit. f. Elek.*, Feb. 10, 17, 24; March 3.

New Books.

BOOK RECEIVED.

STEAM BOILER ECONOMY. A Treatise on the Theory and Practice of Fuel Economy in the Operation of Steam Boilers. By William Kent, A. M., M. E. New York: John Wiley & Sons. 453 pages, 134 illustrations. Price, $4.

Directory of Electrical Societies, Etc.

AMERICAN STREET RAILWAY ASSOCIATION. **Next meeting, New York,** Oct. 9, 10 and 11, 1901.

ASSOCIATION OF THE EDISON ILLUMINATING COMPANIES. **Next** meeting, Sept. 10, 1901.

CANADIAN ELECTRICAL ASSOCIATION. **Next meeting, Ottawa, Ont.,** June 19, 20 and 21, 1901.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS. **Next** meeting, Niagara Falls, N. Y., September, 1901.

NATIONAL ELECTRIC LIGHT ASSOCIATION. **Next meeting, Niagara** Falls, N. Y., May 21-23, 1901.

NEW YORK STATE STREET RAILWAY ASSOCIATION. **Next meeting,** Rochester, N. Y., September, 1901.

OHIO ELECTRIC LIGHT ASSOCIATION. **Next meeting, Put-in-Bay,** Ohio.

PENNSYLVANIA STATE STREET RAILWAY ASSOCIATION. **Next meeting,** York, Pa., Sept. 4, 1901.

SOUTHWESTERN GAS, ELECTRIC & STREET RAILWAY ASSOCIATION. Next meeting, Houston, Tex., April 19-22, 1901.

NORTHWESTERN ELECTRICAL ASSOCIATION. Next meeting, Sheboygan, Wis., last week in June, 1901.

Frequency Changer.

The development of polyphase current working has been so rapid that questions thought to have been definitely determined when a plant was originally erected have afterwards been revived in troublesome form. In early days, for example, the very high frequency of 133 was settled upon as being most likely to satisfy all future requirements. Not many years later it was recognized that this was too high, and a periodicity of 60 became current practice. Still more recently it has developed that while this frequency is apt to stand with respect to lighting, it is too high for certain power purposes, and it has also been found that the best frequency for the latter purposes is too low for lighting. These considerations have brought forth the desirability of a piece of apparatus whereby a frequency may be transformed from a higher to a lower value or vice versa, thus enabling power plants of low frequency to supply lighting current, and permitting lighting plants of high frequency to supply current of the best frequency for power purposes.

An apparatus of this kind, made by the Stanley Electric Manufacturing Company, is shown in the accompanying illustrations. In addition to being a frequency changer, the machine can be built to deliver current of a different phase relation and voltage from that with which it is supplied. The machine, though it performs the function of two different machines, presents the same general appearance as the S. K. C. standard inductor alternator. In operation one-half of the frequency changer is essentially an asynchronous motor and the other half an alternating-current generator. There is, however, but one field coil, which furnishes the excitation for both the motor and generator ends of the machine. The ratio of voltage transformed may be as high as 10 to 1, not, however, exceeding 5000 volts in machines of less than 250-kw capacity. The S. K. C. system of independent phase regulation applied to these machines makes possible also an individual voltage variation of 10 per cent on each phase.

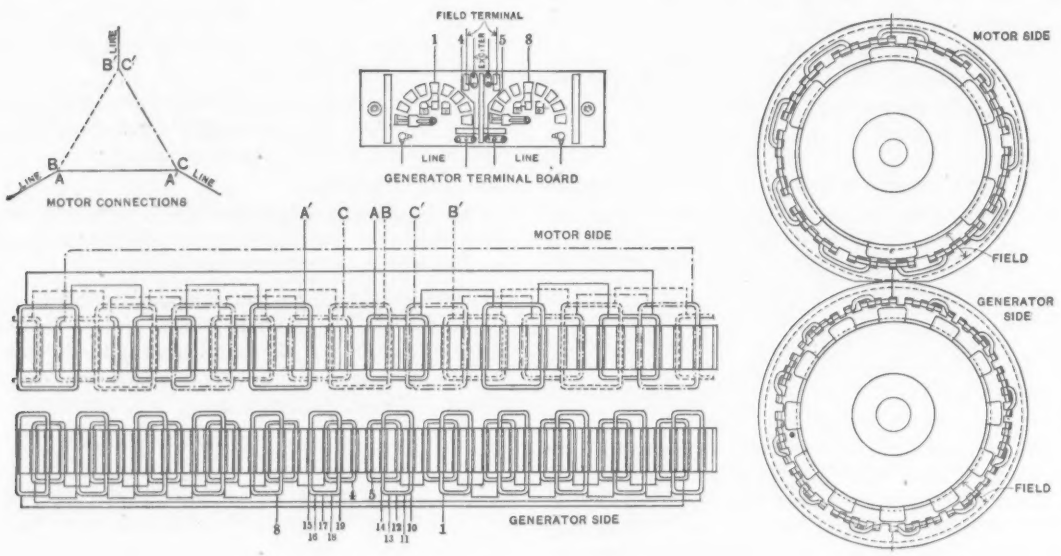


FIG. 1.—PLAN OF CIRCUITS.

The plan of circuits of the machine is shown in Fig. 1. The arma-

ture and armature coils are stationary. The armature is built up of laminated iron and the comparatively small coils are wound and insulated separately and placed in the generator in the exact shape in which they are wound. The inductor or revolving part consists of a mass of cast-steel secured to the shaft with laminated iron projections on its surface, and is without wire connections of any kind.

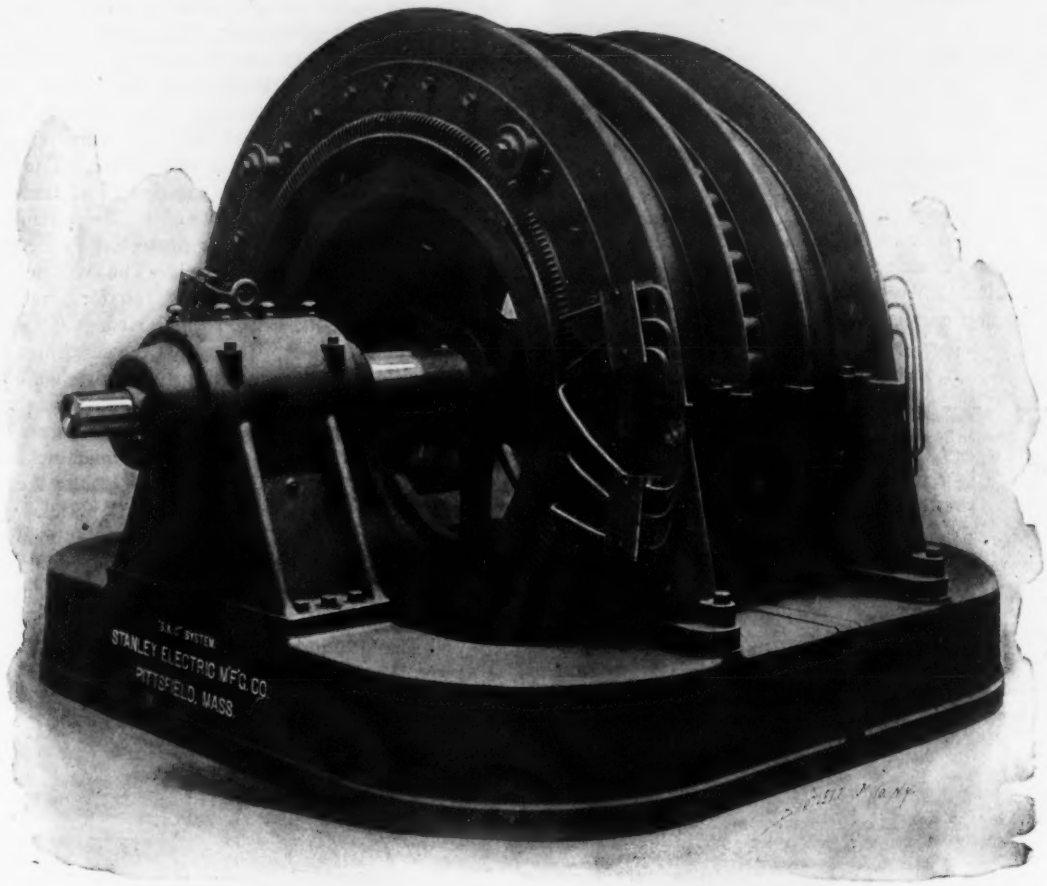


FIG. 2.—FREQUENCY CHANGER.

The armature leads of the generator half and the field leads, are brought to a marble terminal board placed on the machine. The phase regulators may be placed either upon the marble terminal board or on the switchboard panel controlling the machine, as may be desired. The armature leads of the motor half are connected to the line terminals from the switchboard. As illustrated in Fig. 1 all the armature leads are numbered to correspond with the numbers on the terminal board. The field coil, which is stationary, is wound on a copper spool, thereby removing the danger of a discharge breaking down the insulation should the field circuit be opened when fully charged.

English Polyphase Direct Current Motor Generator.

We are glad to be able to present to our readers a description of the latest type of polyphase direct current motor generators and induction motors, manufactured by the Electrical Construction Company, Ltd., of Wolverhampton, England. The Electrical Construction Company is one of the largest British manufacturers, and has recently made extensive additions to its factory, whereby it is now able to manufacture electrical apparatus of the largest size. As one of the first English manufacturing companies to enter heavily into the manufacture of the polyphase apparatus, a description of their latest designs in this line will doubtless prove interesting.

The motor-generator set illustrated consists of a synchronous polyphase motor, driving a six-pole direct-current generator. The normal output of the generator is 140 kilowatts at 200 to 230 volts, with a 25 per cent overload for two hours. In order to save floor space, and also to give the highest efficiency, it was decided to have only two bearings for the combined machine, and in order to get sufficient rigidity in the rotating element, both the rotor of the motor and the dynamo armature are built upon one cast-iron frame, with a specially long boss, into which the shaft is driven under hydraulic pressure. The shaft being by this construction relieved of all torsional stress, except the small amount due to friction of the bearings, it is unnecessary to key it to the boss.

The motor is wound for eighteen poles, and therefore gives a synchronous speed of 400 revolutions per minute, when supplied with current at sixty periods per second. The two-phase supply is at 1000 to 1100 volts, the separate phases being connected on opposite sides of the stator, to terminals covered by glass doors. The stator winding consists of 216 form-wound, interchangeable coils, well insulated and imbedded in open slots cut in the laminated core, which is supported by and bolted to a strong cast-iron frame, accurately bored out to receive the core plates.

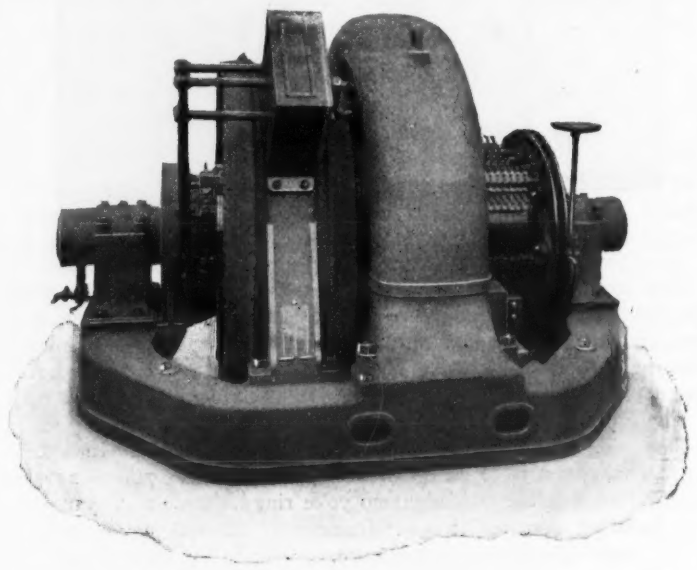


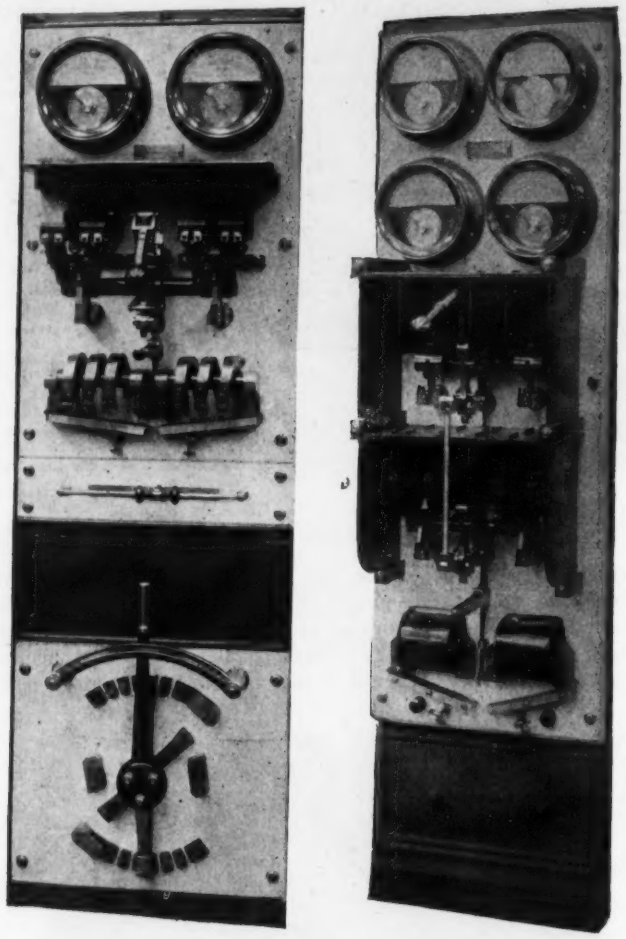
FIG. 1.—200-HP POLYPHASE DIRECT-CURRENT MOTOR-GENERATOR.

The rotor has 165 equal and equally spaced, partially enclosed slots, each slot having one conductor of solid copper; the conductors are

connected by sheet copper connections to form a three-phase star winding, one terminal of each group being bolted to the cast-iron frame of the rotor, while the other ends are connected to three collector rings on the other side of the core. From these collectors the rotor current is conducted by triplicate sets of copper brushes through three bare copper rods to the resistance and short-circuiting switch, which is carried by the stator frame.

The dynamo is of the multipolar, slot-wound type, usually adopted for electric traction work. The armature is of the barrel-wound type, the conductor loops being machine formed, continuous, and without joint except at the commutator. They are imbedded in straight-sided slots and held in position at the core by hardwood keys and additionally held by metal bands, which secure the helical portion of the winding. The laminated core is rigidly bolted direct to substantial cast-iron side cheeks, and the laminæ, which are sixteen mils thick, are effectively ventilated.

The commutator is twenty-four inches in diameter, and has a working face of ten inches, the average e. m. f. between the segments being approximately 6 volts. There are forty-two carbons for the collection of the current, each carried in a separate holder having the usual adjustments, the brush ring being also in connection with the worm gear.



FIGS. 2 AND 3.—DIRECT AND ALTERNATING SWITCHBOARD PANELS.

The magnet system consists of a massive cast-iron yoke ring, divided about the horizontal axis, and into which are cast six projecting magnet cores each formed of high permeability steel plates. The pole shoes, which are readily removable, are laminated, the magnets being shunt wound on removable ferrules.

The following are the leading dimensions of the machine:

	Feet.	Inches.
Distance centre to centre of bearings	7	2
External diameter of dynamo yoke ring	7	0
External diameter of stator frame	5	9
Internal diameter of stator core	4	4
External diameter of rotor	4	3⅞
External diameter of D. C. armature	3	6
	Tons.	Cwts.
Weight of rotating portion	5	0
Weight of bed-plate	2	1
Weight of stator	2	4
Weight of magnets	7	4

Fig. 2 shows one of the direct current switchboards. This is fitted with an ammeter, a voltmeter, a double pole automatic circuit breaker, shunt regulating switch, and motor starting switch. The automatic circuit breaker is fitted with renewable carbon contacts to take the arc when opening circuit. The design of this is such that it can also be used as a main switch. Should it be closed on an overload or short circuit it immediately opens, the contact maker being independent of the handle. The resistances for starting and regulating are fixed at the back. The panel slabs are of white marble, and the framing is built up of wrought-iron angles.

Fig. 3 shows one of the alternating current switchboards. These have iron frames and marble slabs similar to the direct-current panels, each panel is fitted with an ammeter, a voltmeter, and a double-pole circuit breaker in each phase. The two circuit breakers are operated by one handle; the design of these is similar to those on the direct-current switchboards. The circuit breakers being for high tension, the contacts are protected by deep partitions of non-inflammable insulating material. The voltmeters are operated at low tension, pressure reducing transformers being provided for each and fixed on the back of the board.

The switching gear provides for the machines being started either from the direct or the alternating current side. When starting from the alternating side, the resistance carried on the stator frame is in circuit with the rotor, and prevents too large a current passing, on closing the main switch. After the machine has speeded up, this resistance is short-circuited by means of the three-way switch. The resistances are made of German silver plates.

The same company makes a line of inducion motors in various sizes up to 50 horse-power, one of which is shown in Fig. 4. They have short-circuited rotor windings, the starting current being reduced when necessary by the insertion of an auto-transformer between the mains and the motor. The stator coils are machine-formed and insulated, before fixing in the slots, which are of the open type. The heavy cast-iron frame is accurately bored to receive the core plates, which are fixed by end rings locked by a notched ring of phosphor bronze, and fitting into recesses in the frame. The rotor winding consists of rectangular copper bars bolted to solid gun-metal end rings, thus making good contact without using any solder. The slots are semi-enclosed, while the core plates are carried by a cast-iron spider with end plates locked similarly to those of the stator. The bearings are cast with the side flanges. The brushes are of phosphor bronze lined with white metal, lubrication being by means of oil rings. The radical clearance between the rotor and the stator is one-thirty-second of an inch in the one horse-power and one-sixteenth in the fifty horse-power size. The rotors are carefully balanced and every machine thoroughly tested before being despatched. The particular machine illustrated is the enclosed type, and specially suited for working in fiery mines, flour mills or in dusty or wet situations.

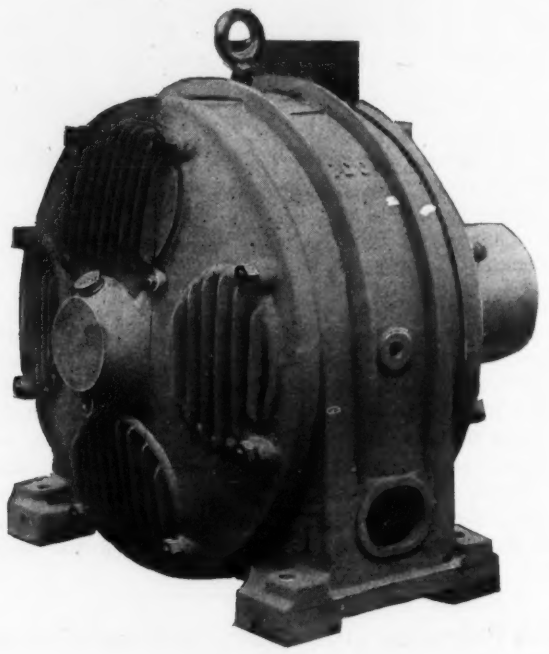


FIG. 4.—E. C. C. INDUCTION MOTOR.

The Development of Telpherage.

FIG. 1.—TRAILER WITH BAGS IN SLING.

The word "telpher" and the art of telpherage bid fair to attract considerable attention in the mechanical and electrical fields, owing to the persistence and success with which the new industry is being pushed. It will, perhaps, be remembered that an article appeared in these pages in the issue of May 19, 1900, in which some details were given as to the system and its proposed development. Since that time a great activity has been shown by the Consolidated Telpherage Company in preparing to place its system on the market, and it may now be confidently stated that nothing stands in the way of rapid extension on commercial lines. During the past year the company has had a line in constant operation at the factory of the Crocker-Wheeler Company, at Ampere, N. J., crossing the grounds and connecting two departments of the works. More recently a contract has been closed for a brewery in St. Louis, while a plant is being installed in the Yale & Towne Works, at Stamford, Conn., and another has been contracted for to handle ashes at the Singer sewing machine factory, at Elizabethport, N. J. Earlier demonstrations having thus proved satisfactory to all concerned, and the inrush of inquiries, orders and new business from every quarter of the globe demanding proper capitalization, so that even the largest contracts can be fulfilled, the United Telpherage Company has been formed, with headquarters at 20 Broad street, and with the following officers: H. McL. Harding, president; C. M. Clark, treasurer; W. T. Wallace, secretary; Clark & MacMullen, consulting engineers; to whom may be added Messrs. E. D. Adams and C. F. Clark, trustees. It is rarely that any new enterprise in electrical development starts out under such promising auspices, both with respect to conservative management and commercial and engineering ability. Mr. Harding, who has been prominent for several years past in the affairs of the Sprague, Westinghouse and Walker companies, has of late given his whole time to the exploitation of telpherage, and to him more than to any one else is due its present promising condition. The new company has a capitalization of $1,500,000, and is organized under the laws of New Jersey.

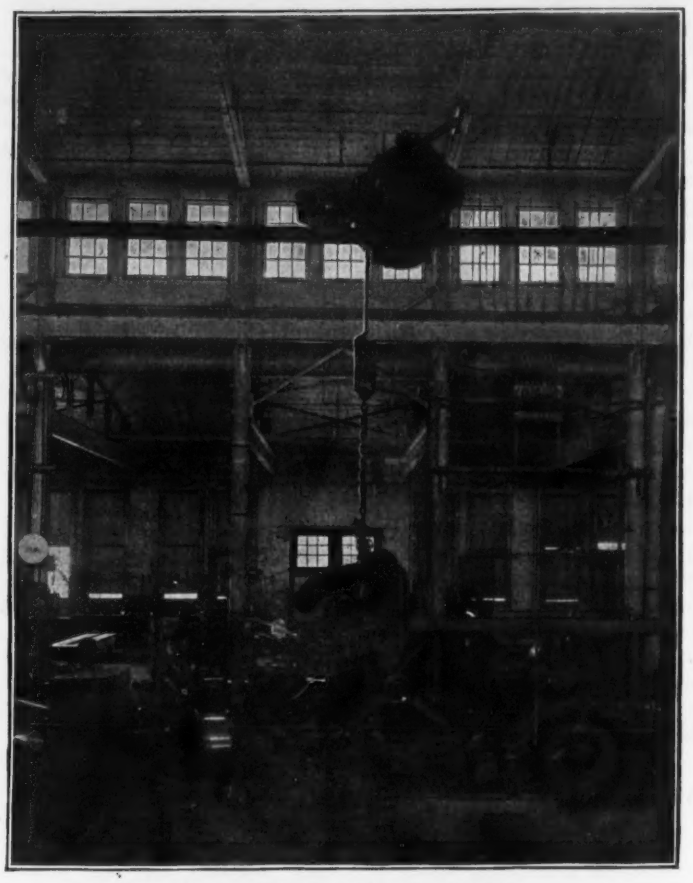
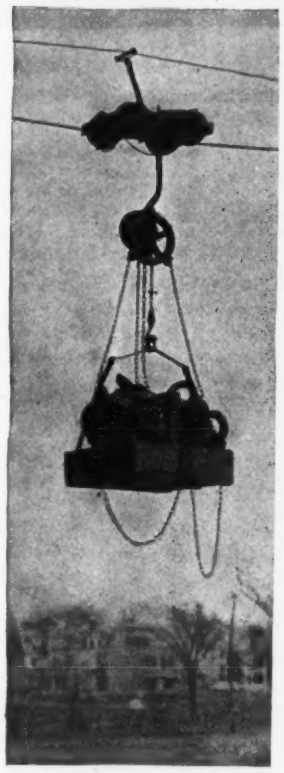


FIG. 4.—TELPHER LINE IN FACTORY.



FIGS. 2 AND 3.—TELPHERS CARRYING FREIGHT AND MAIL BOX ACROSS LOTS.

In our former article of about a year ago, just referred to, some illustrations were shown of the apapratus and methods of operating telpher lines, in which, as our readers are aware, the telpher travels along a bearing cable and takes current by rolling contact from a lighter wire suspended just above it. We are now able to illustrate the standard apparatus, which has been developed and perfected in the interval, and to show some of its performances. Either a single unit telpher or a double unit may be employed for the work, with or without a trailer, the single unit consisting of two small enclosed motors and the double unit of four motors. The hanging or slinging arrangements attached to the telphers or the trailers are of a great variety of shapes and styles, adapted to the transportation of all kinds of loose or easily divisible material, such as bags, barrels, sand, coal, ashes, ores, bricks, fruit, etc.; while a ready combination of one or two trailers lends itself easily to the transportation of long pieces, such as lumber, rails, tubes, drain pipe, etc. One of the most remarkable things in connection with the work is to witness the manner in which telpher units of not to exceed one-fourth to one-half horse-power will travel at a rate of five or six miles an hour with loads of several hundred pounds on lines running around sharp curves and even up sharp inclines. The current consumption is surprisingly small.

At the present time, in addition to the production of its apparatus, the company has found it a task of no mean description to attend to all the applications which have poured in upon it from commercial and engineering concerns for agencies, and these, both domestic and foreign, are being assigned as rapidly as possible. The development has attracted the liveliest interest abroad, and was recently investigated by the engineers of a leading English electrical firm; while one of the requests from Russia came from Prince Hilkoff, who desires to equip several miles with the system, which is obviously much lighter and cheaper to construct than railroads, while it does not encroach in any way on highway rights and does not impose any difficulties as to crossings, etc., along the routes it traverses. The utilization of the system for transporting mail and express matter

has already been taken up, and applications have been received from managers of telephone and trolley lines, who see in this light and flexible electrical system a means of getting an additional service out of their pole lines, while at the same time subserving for purposes of varied freight transportation the necessities of the districts they cover. The conveyance of mail matter is peculiarly within the function of this apparatus, as letters and papers can be concentrated into very small bulk for transportation, and the deliveries can be made with great frequency where, under existing conditions, the postman can go over his route but once or twice a day at the most.

In connection with the handling of mail matter it may be stated that the company has already been invited to consider the question of transporting mail in cities by means of underground tube systems, where the conditions would if anything be even more favorable than with ærial lines. At the present time mail in transit from post-office to railway depot is subject to all the vicissitudes of interruption by street blockade, weather, etc., and is frequently delayed on that account. The use of pneumatic power has already been tried in this direction, but it is plain that in this field, as in others, electricity will readily prove its superiority and be generally adopted for such work. In the meantime the company has its hands more than full of propositions for equipping wharves and docks, railroad depots, factories, plantations, mines, and a host of other establishments where goods have to be transported continuously in relatively small bulk; and it is only reasonable to predict that we shall now see the fruition of the work in this new industry, which was attempted even before the electric railway began its great development, and which may be said to have awaited the perfecting of apparatus and details not available in the earlier days. Except so far as it may do some of the work hitherto assigned to cable haulage systems, telpherage appears to cut out an entirely new province of its own, and it thus gives opportunity for considerable utilization of current and motive power, as well as new and profitable employment of capital.

A Simple Connection Between Turbines and Generators.

The illustrations given herewith show an arrangement of turbine-driven generator, which has been installed for the Massachusetts Chemical Company at Walpole, Mass., and manufactured by the Thresher Electric Company. The object in view was to make the simplest possible mechanical connection between the dynamo and the turbine, which is in accordance with the present trend of engineering. In the form shown, the generator is an essential portion of the turbine. This construction obviates the friction of bevel gear or belting ordinarily used with water powers, which amounts in the first case to about 18 to 22 per cent, and in the latter from 15 to 19 per cent. A considerable saving of power is thus effected, which in the ordinary form of connection between the generator and turbine is lost in transmission from the turbine to the generator.

FIG. 1.—GENERAL ARRANGEMENT OF TURBINE AND GENERATOR.

In the general plan (Fig. 1) are shown the entire turbine and generator with the manner of connection between the shaft of the latter and the waterwheel. In Fig. 2 the general arrangement of turbine and generator is shown, with the plan of the oil pockets and bearings. Fig. 3 gives a full view of the generator on its pedestals, which happened in this instance to be the top of the turbine itself, as the head was only about 15 ft.

Certain original features are embodied in this mode of construction, among them the flexible coupling on the shaft between turbine and generator, the feathered coupling permitting free longitudinal action and making the machine self-contained and supported separately on its own thrust bearings. These are composed of several annular rings about the shaft, which bear on a number of babbitted projecting surfaces. The shaft of the turbine may be varied in length, depending upon the head of water, and having the generator either over the penstock or over the head of the tail race, the flexible coupling taking care of any expansion or contraction of the shaft without throwing any compression strains on the turbine shaft. The

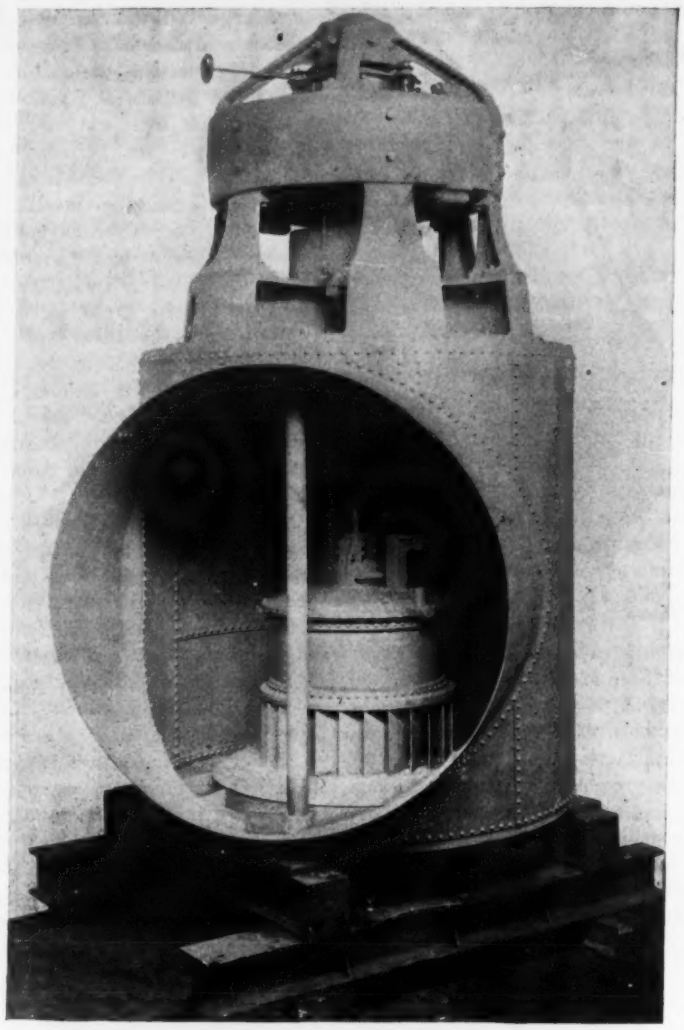


FIG. 2.—TURBINE AND GENERATOR.

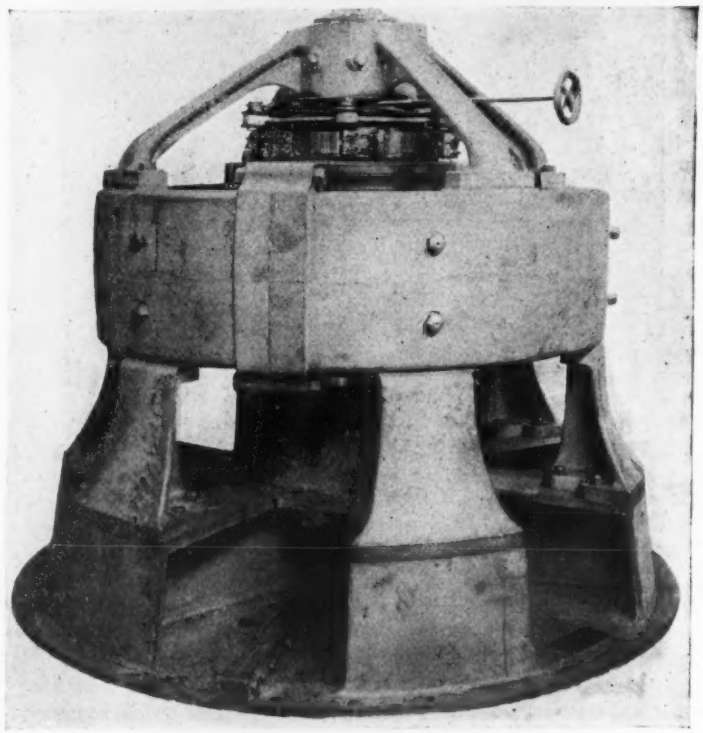


FIG. 3.—THE GENERATOR.

lower and upper bearing of the generator are overhung, having a heavy umbrella-shaped form projecting into the oil pocket containing the lubricant. An oil bath surrounded by a water jacket encloses the annular rings, and projecting surfaces mentioned above.

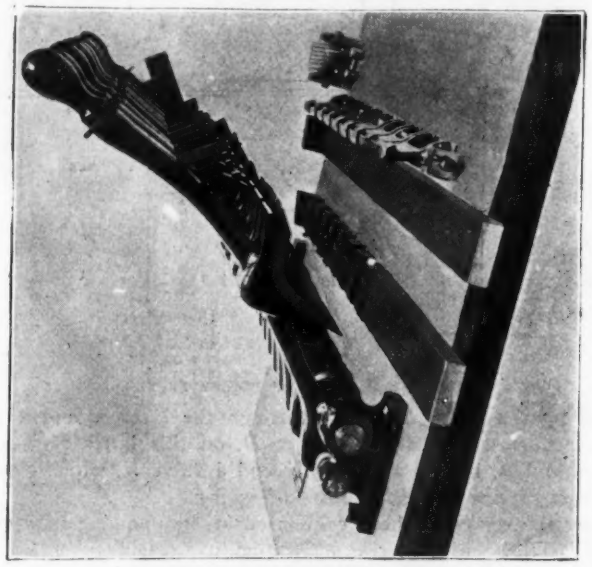
Oil circulating ducts with which the pocket is provided, keep the oil in constant circulation, which is also kept cool by the surrounding water jacket. No oil can get down the shaft, and perfect alignment is secured for the armature.

In the plant of the Massachusetts Chemical Company there were two sizes of machines used, one of 80 kilowatts and 150 r. p. m. at 600 volts, the other of 125 kilowatts and 200 revolutions at 600 volts. The turbines employed were made by the Stillwell-Bierce & Smith-Vaile Company.

It can be easily seen that a simple design of this nature possesses great advantages over the belting or gearing arrangements, and is more easily regulated. First, the moving parts are simpler, and presenting to the whole revolving mechanism less inertia (upon which the regulation largely depends), they respond more quickly and with greater harmony to the controlling device, which is connected to the gates that regulate the turbine. Second, the generators dispense with the racket and vibration produced by gearing from turbines to horizontal generators. Third, there is greater efficiency of transmission. Fourth, the unit is more certainly regulated for speeds of variable loads, and since it takes less space and foundation, no provision is needed for any movement of the commutator along the length of the brushes, since these generators do not need lateral movement of the commutator to produce uniform wear.

Multiple Switch Automatic Starting Rheostat.

The Cutler-Hammer Manufacturing Company, Milwaukee, Wis., has designed a new starter for large motors, which, in construction, differs from that ordinarily used for small motors in that the sliding contact is entirely done away with and a system of switches substituted therefor. With this multiple switch system there is no sparking at the switch in starting a motor, whether under load or not, and it is not necessary to divide the rheostat into as many sections, as is usual in the case of the ordinary type. The peculiar construction of the contact on these switches insures a good contact the instant any contact at all is made. The switches differ from the ordinary knife switch in that they do not have to be pushed into clips before their full carrying capacity is obtained. The contact is made by a large number of thin leaves of brush copper which press up against a hard-rolled copper surface with sufficient scraping motion to keep the surfaces clean and bright. A switch built on this principle will carry, without heating, 250 amperes per square inch of contact surface, whereas the ordinary commercial knife switch is rated by the underwriters at but 50 amperes per square inch of contact surface.



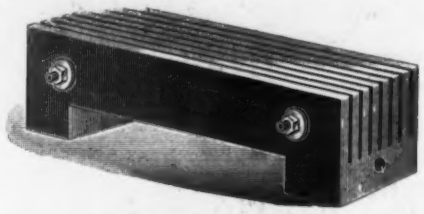
MULTIPLE SWITCH-STARTING RHEOSTAT.

Referring to the illustration, it will be noticed that the first switch on the right hand side is held closed by an electromagnet, and that all the other switches are held closed by latches. In front of each switch is placed a pivoted cast iron stop, so arranged as to prevent any of the switches from being closed, until the switch next to it on the left has previously been closed. The cast iron stops, therefore, constitute the interlocking mechanism. When the supply of current is shut off the first switch on the left opens and allows the stop on switch No. 2 to drop so that this switch also opens, and releases the catch on switch No. 3, and so on until all the switches open automatically.

Interchangeable Shunts.

The interchangeable shunt feature lately developed in connection with the Whitney instruments handled by Messrs. Machado & Roller, 203 Broadway, New York, has, it is stated by this firm, been meeting with much approval from critical station men and other large users.

The scheme that has been developed involves not only making all shunts of the same capacity interchangeable with each other, but all of the ammeters themselves, whatever their capacity or style likewise interchangeable in so far as each requires the same number of millivolts difference of potential to cause the needle to swing to full scale. By adopting this plan, it is possible to compare all of the ammeters on a given board with one another irrespective of their capacities and without interfering with the shunts or busses. To do this the leads of each meter are disconnected from their several



INTERCHANGEABLE SHUNT.

shunts and connected in parallel to a single cell of dry battery, sufficient resistance being, of course, interposed to cut down the potential to a point where the meters show full scale. If any one of them should fail to so indicate it is evidently out of calibration by the percentage that the indication bears to the full scale indication, and the meter can either be run with this correction factor or sent away to be adjusted. A point of particular value in the latter event is that the shunt itself need not be removed, as the drop that it gives across the contact studs is a standard and known quantity.

In the larger plants it is usual to keep on hand a portable millivoltmeter, which can always be attached to any shunt, and its readings compared with the station instrument to check it, and which can be used in place of the latter if at any time it should be necessary to send it away.

It is claimed that the shunts themselves will never vary, as they are specially made by milling out solid blocks, so as to obviate the soldered contacts usually employed, and which are sources of possible error. As the accompanying illustration shows, the terminals on the shunts to which the instrument leads are attached are exceptionally heavy in order that contact errors at these points, which are another source of difficulty with shunt ammeters, may be minimized.

Other features of the devices, such as the temperature coefficient of the shunt material, have been the subject of much careful thought and investigation, and the final form arrived at is said to be conducive to highest commercial accuracy.

A British Motor Driven Feed Pump.

A compact and satisfactory type of motor driven feed pump outfit has been introduced recently by the well-known English firm of Mather & Platt, Ltd., of Manchester, to be used with either a direct or an alternating current motor.

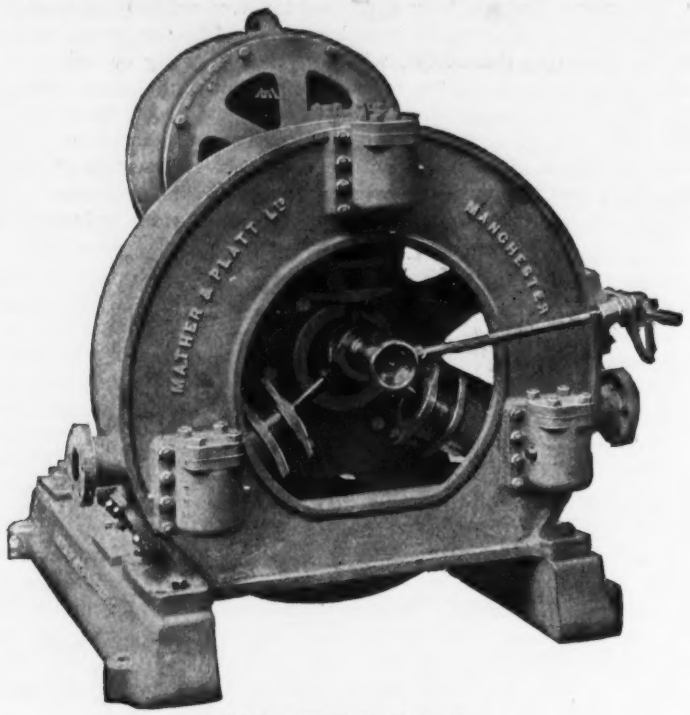
The entire regulation of the pump is a mechanical one, and consists in altering the stroke of the plungers according to the required output, the result being that the work of the plant can be quickly reduced from the maximum to zero, or *vice versa*, without any wasteful absorption of power by resistance.

This pump consists of three cylinders mounted radially on a frame at angles of 120 degs. with each other, the plungers being driven from a crank-pin by connecting rods in the ordinary manner. The crank-pin is arranged eccentrically on a disc fitted into a recess in an internal toothed wheel, which engages with a pinion on the motor shaft. The rotation of this disc, which causes the desired alteration of the stroke, is obtained by gears situate in the hub of the internal wheel, and operated by a suitable hand-lever conveniently arranged.

An indicator, fixed to the stroke varying attachment, shows the

length of stroke, and therefore the corresponding output of the pump at the time. To change the stroke, all that is required is to raise the hand-lever until the indicator shows that the desired amount of water is being discharged, whereupon the lever is released. The lever can be operated directly in the manner described, or from a distance by suitable connections, and in the latter case is peculiarly adapted for use with hydraulic accumulators, when it can be readily attached to and controlled by the ram.

The main framework, cylinders, and valve-boxes are of cast-iron, and the plungers, bushes and glands of gun-metal; mild steel connecting rods drive the plungers through the medium of ball and socket



MOTOR-DRIVEN FEED PUMP.

joints, which are readily adjustable. The gland flanges are not rigidly attached to the bodies, but are designed to accommodate themselves in case of the gland-nuts being tightened unequally, thus preventing undue friction on the plungers. One of the principal features is the arrangement of the valve boxes, which are easily removable, and in which the valves themselves are readily accessible. The motor is steel-clad, with the windings entirely protected from injury. The openings in the end plates can be covered with gauze if desired, and this, while not interfering with the ventilation, allows the motor and pump to be used in coal mines and other places where such protection is highly desirable.

Carborundum for Commutator Polishing.

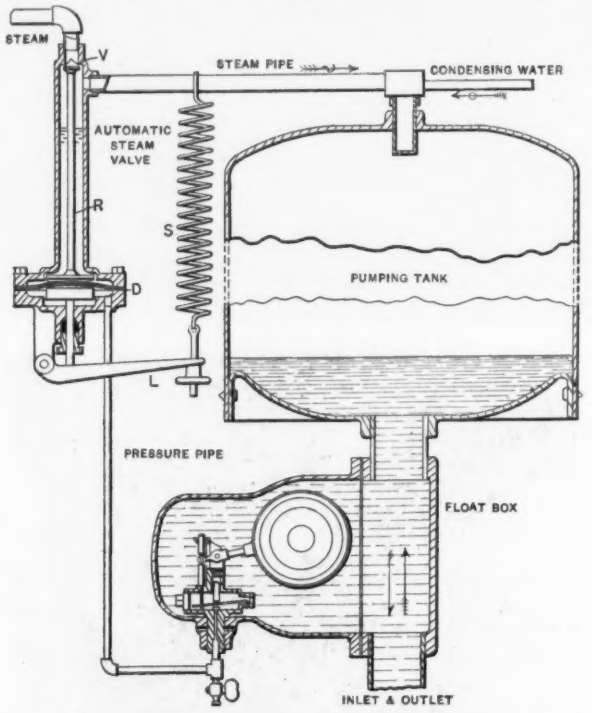
A matter of much interest to power station superintendents, and all who are operating direct-current apparatus, is the new field which has been entered by the Carborundum Company, of Niagara Falls, N. Y., in the use of carborundum paper for polishing commutators. Heretofore this work has been done with sandpaper, a material little adapted for metal work of any kind on account of its comparative softness and inability to keep a sharp cutting edge. Emery paper might, of course, have been adopted for this purpose, except for the fact that it consists largely of iron, which finds its way between the segments of the commutator and quickly short circuits them. In carborundum has been found a material which is absolutely a non-conductor, and at the same time many times harder and sharper than sand or emery, making it an ideal abrasive for this important operation. Too much stress cannot be laid on the proper care of commutators. Properly and intelligently polished, they require turning down only at long intervals. However, if the high spots and flat places are once fully developed, no amount of polishing will again bring the commutator to a true circle. Here let us consider the action of sandpaper. It is a comparatively slow-cutting material, and in applying pressure to make it cut, follows all the irregularities of the surface, leaving the contour the same as before. Carborundum, being of such great sharpness, the same pressure is unnecessary, and the high spots are cut more rapidly than the flatter portions, the tendency being always to bring the commutator back to its original perfect form.

Recent tests at some of the large power stations at Niagara Falls have shown that one sheet of carborundum paper does the work of from 10 to 20 sheets of sandpaper. In addition, the commutator is left with the high glassy finish always sought for by the experienced dynamo tender; and the labor is considerably lessened.

Automatic Steam Boiler Feeder.

An apparatus known as the "Waterhouse Automatic Steam Boiler Feeder," is now being shown in practical operation by Harrison & Watson at the works of William H. Harrison's Sons, 1708 Ludlow Street, Philadelphia, Pa. By means of this apparatus, water is fed into the boiler from a well or from any level, and the water maintained in the boiler at a constant level by automatic means. The system is illustrated in the accompanying figure, in which, however, the water reservoir or "pumping tank" is shortened in section.

The water tank is placed above the level of the boiler and water drawn into the same by a vacuum formed by the condensation of steam. When the tank is filled the water is caused to flow in the boiler by gravitation, being displaced by steam from the boiler. Steam is let on and shut off by the action of the inflowing and outflowing water. The direction in which the water flows while on its way from the supply tank to the pumping tank, is shown in the sketch by whole arrows, while half arrows show the direction from the tank to the boiler. The steam path is shown by the arrows passing through an *S*. Steam enters through the automatic steam valve shown, to the top of the pumping tank. This valve is normally



SECTIONAL VIEW OF BOILER FEEDER.

closed by the spring *S* acting through the lever *L* and a sliding stem, against a flexible diaphragm *D*, on this latter rests a disk-headed rod *R*, having at its upper end a valve *V*, which closes the steam passage with the full force of spring *S*.

After the steam has been condensed in the pumping tank and the latter is filled with water, a small quantity of condensing water returns from the boiler under pressure, as shown by arrows with a circle, and imparts pressure within the tank which is transmitted through the steam pipe to the automatic steam valve. This pressure acting upon the greater surface of the flexible diaphragm *D* depresses it and allows the valve *V* to open, thereby admitting steam, which continues the pressure upon the diaphragm *D* and keeps the valve open. The steam then presses upon the water and sets up a flow by gravitation into the boiler. When the level of the water settles below the float box, a float is caused to fall, which opens a very small check valve. When this valve is opened pressure is transmitted through a small pressure pipe to the automatic steam valve and acts under the diaphragm *D*, which counteracts the pressure of steam above it and allows the spring *S* to close the valve *V*, which operation completes the cycle above described.

Hand Oil Pump.

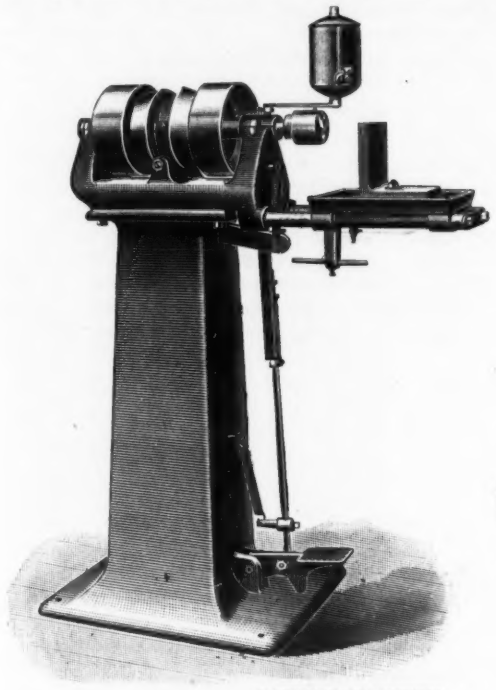
The "Universal" hand oil pump illustrated herewith has been brought out by the Lunkenheimer Company, Cincinnati, Ohio. It is easy to attach, fill and operate, and is said to work well under high pressure. It can be made to attach either vertically or horizontally by transposing plug *B* and shank *A*, which are interchangeable. This permits of adapting the pump to meet any requirements of position; i. e., it can be connected either into the steam pipe or steam chest.

HAND-OIL PUMP.

The filling-hole is closed by a hinged cap, which keeps out dust and dirt, and in addition, there is a removable wire gauze strainer to insure clean oil. All parts about the pump are heavy, large, well constructed and not liable to get out of order easily. Where required, these pumps can be furnished with brass instead of glass body, as shown.

Improved Tapping Machine.

The accompanying cut illustrates a recently designed machine for tapping a large variety of work not too heavy to be readily handled, such as nuts, couplings, brass, malleable and cast-iron fittings, straps and castings of frames of light machines, etc. It will carry a tap from the smallest size to ⅝ inch, while ¾ inch and 1 inch taps can be used on a large variety of work. Ball bearings, as thrust collars, lessen the friction and enable the machine to perform its work with much less power. The spindle is driven with two 3-inch belts, and runs at a speed of from 400 to 600 r. p. m., according to the size of tap and nature of the work.



TAPPING MACHINE.

The machine is fitted with a trip that reverses the tap automatically after reaching any given depth, thereby saving time and breakage of taps.

It is built in three different sizes by Mr. Harvey Hubbell, Bridgeport, Conn.

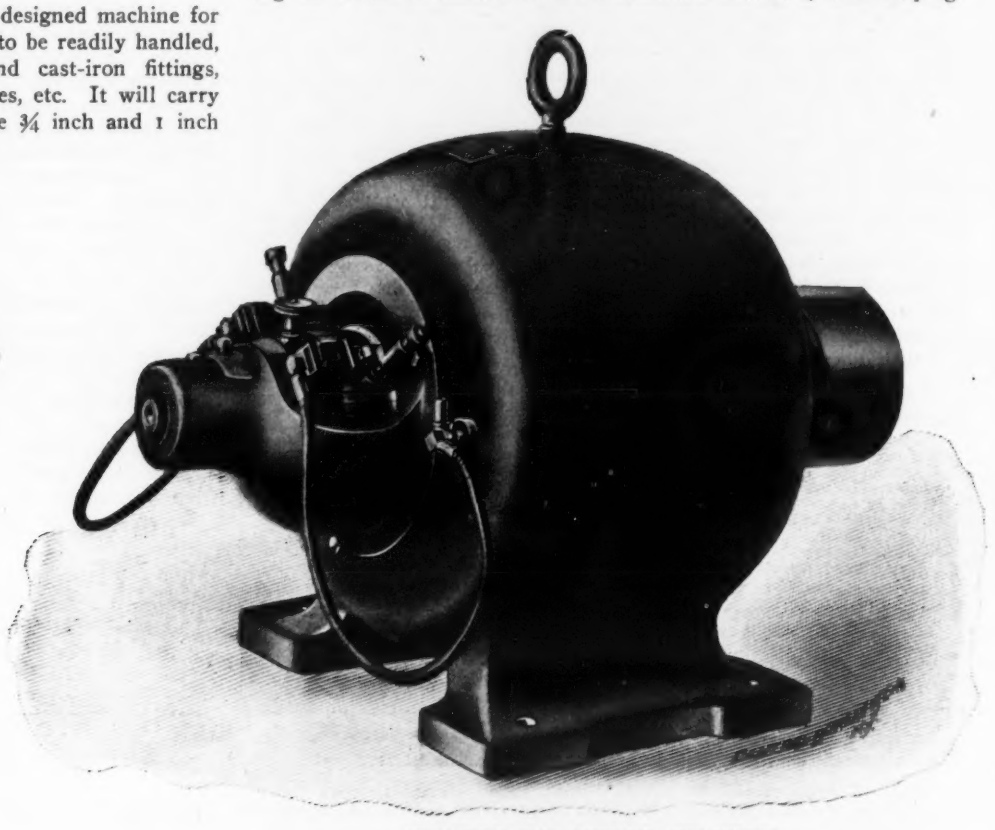
Miniature Portable Searchlight.

The portable searchlight illustrated herewith is manufactured by the Strobel & Wilken Company, 591 Broadway, New York. It is stated that the batteries used do not deteriorate when not in use, and consequently the lights can be shipped long distances. It is stated that with ordinary use one set of batteries will last from four to six months. The searchlight is provided with an improved contact lever made of tempered steel, and cannot get out of order. The case is covered with black leather with nickel-plated trimmings. It is 1⅝ inches in diameter and 8 inches long. It is, therefore, a compact and portable device. It is called by the makers the "Yankee Searchlight," and is recommended for the use of meter readers, sportsmen, doctors, tourists and all others requiring a temporary and satisfactory light.

PORTABLE SEARCHLIGHT.

Improved Designs of Dynamos and Motors.

The accompanying illustration shows a motor of new design now being placed upon the market by Messrs. Palmer & Olson, 210 Centre street, New York. This machine is of the multipolar type, and differs from others in the fact that the entire body and base are one casting. The bearing at the commutator end is the only separate part. It is closely fitted to the main casting, and held securely in place by two bolts. The pulley end of the field frame has ample radial opening for a full circulation of air around the armature, thus keeping the temperature of the latter as low as possible. It is evident that this motor is built for work, and in that regard the makers claim for it a high efficiency.



NEW IRON-CLAD DYNAMO AND MOTOR.

Among the features claimed for these machines are: Noiseless running, interchangeability for floor or ceiling work; it will run on full load for an indefinite period with very slight rise in temperature; accessibility to the self-adjusting brushes; protection of the armature from mechanical injury, besides others of practical importance. Apart from the electrical and mechanical features of these machines, their graceful design is striking.

NEWS OF THE WEEK.

Financial Intelligence.

THE WEEK IN WALL STREET.—Call money closed at 2½ per cent, nominally. Time money during the week was practically unchanged as to price. The closing rates are 3¼ to 3½ per cent for 60 to 90 days, 3½@4 for 4, 5 and 6 months. Mercantile paper was quiet during the week and closed at 3½@4 per cent for 60 to 90 days; bills receivable, 4@4½ for choice 4 to 6 months single names and 5 for others. Stock values continued to advance; speculation was bullish and untempered and displayed great activity. The steel stocks are higher on the success of the consolidation plan, and the shares of the constituent companies are also higher. The United States Steel stocks were admitted at the Stock Exchange on Thursday and developed strength on general buying and confident talk of their dividend prospects. The other industrials are to some extent favorably influenced by the activity and strength of the steel stocks. The traction stocks were irregular and active, there being good trade in Manhattan, which stock advanced on reports that the equipment of its lines with electrical power will soon be completed, and may have a favorable effect on the net earnings of the company. Metropolitan Street Railway closed with a net gain of 4⅝ points, the closing price being 166¼ ex-dividend. The number of shares sold was 50,910. Brooklyn Rapid Transit displayed less activity than during the previous week, the sales amounting to 159,360 shares. The stock closed, however, with a net gain of ¼ point; the range of prices was between 78¾, the lowest, and 84 the highest. Great activity was shown in Western Union, which is rapidly approaching par. There were 218,800 shares sold, which is the highest point reached in many weeks. The closing price was 96. General Electric continues to advance and closed with a net gain of 4 points. The transactions were rather limited, the sales amounting to 7000 shares. Electrical Lead Reduction was active the latter part of the week, and sold above 5, closing at 5 bid. American Bridge was active and strong toward the end of the week, the common stock selling up to 47⅝. The preferred stock sold above 104, with a net gain over the previous week. Southern Light & Traction bonds advanced to 80½. As far as reported there has been no trading for the past few days in the stock, although the bonds have recently shown considerable activity. During the week trade on the outside market was reduced by the withdrawal of United States Steel to the Exchange, which had, however, the effect of bringing other distinctive outside securities into greater prominence. The general tendency of prices during the week was upward. St. Louis traction securities were easy. The weakest issues were Consolidated Equipment and the transportation stocks. The former lost 3¼ points net and the latter uniformly sagged under the low prices previously recorded. Following are the closing quotations at the centers named:

NEW YORK.

	Mar. 23.	Mar. 30.		Mar. 23.	Mar. 30.
General Electric	215	217	Electric Vehicle	15	13
Brooklyn Rapid Transit	82¾	83	Electric Vehicle, pfd	25	25
Metropolitan Street Ry.	163⅜	166¼	General Car	2	2
American Tel. & Cable	97	97	Illinois Elec. Veh. Tran.	1	1
Western Union Tel.	88⅜	96	Hudson River Tel.	—	120
American Dist. Tel.	36	—	N. E. Elec. Veh. Tran.	2⅞	2¾
Commercial Cable	160	—	N. Y. Elec. Veh. Tran.	4	3¾
Electric Boat	24	24	Tel. & Tel. Co. of Am.	7	6
Electric Boat, pfd.	51	51	N. Y. & N. J. Tel.	—	178
Electric Lead Reduc'n.	5	4⅞			

BOSTON.

	Mar. 23.	Mar. 30.		Mar. 23.	Mar. 30.
New England Telephone	139	—	Erie Telephone	50¾	49½
Mexican Telephone	—	3¼	General Electric, pfd.	192	—
Westinghouse Electric.	62	62½	Am. Tel. & Tel.	169	167½
Westinghouse Elec., pfd.	71	—	Boston Electric Light	—	—

PHILADELPHIA.

	Mar. 23.	Mar. 30.		Mar. 23.	Mar. 30.
Electric Storage Battery	72	72	Philadelphia Electric	6⅛	5¾
Elec. Storage Bat., pfd.	74	74	Pa. Electric Vehicle	½	½
Elec. Co. of America	8⅝	8¼	Pa. Elec. Veh. pfd.	½	½
General Electric Auto	—	—	Am. Railways	38	39½

CHICAGO.

	Mar. 23.	Mar. 30.		Mar. 23.	Mar. 30.
Chicago Edison	154½	154	Chicago Telep. Co.	265	220
Chicago City Ry.	260	260	Union Traction	15	16
National Carbon	153¼	153¼	Union Traction, pfd.	56½	56
National Carbon, pfd.	82	82	Northwest. Elev. Com.	39	40

*Asked.

WESTINGHOUSE ELECTRIC & MANUFACTURING.—The stockholders of the Westinghouse Electric & Manufacturing Company, at a special meeting on Feb. 20, authorized the increase of the company's stock from $15,000,000 to $25,000,000, the new stock to have the same rights and privileges as the "assenting stock" now outstanding. They also authorized the board of directors to sell the new stock in their discretion at not less than par. The directors have authorized the sale of $3,000,000, par value, of the new stock at $55 for each $50 share, the stock to be offered at that price to the stockholders at the rate of one share for every five shares of stock now held. Stockholders of record at the closing of the transfer books on April 9 are offered the privilege of subscribing. A syndicate has been formed to take the portion of the stock which shall not have been subscribed for by the stockholders on or before the 20th day of April, 1901. The new shares will be entitled to participate in all dividends declared after May 15 upon stock of the same class. Failure to pay the final installment of the subscription price will forfeit all rights in respect of the stock subscribed for and of the installment previously paid.

WESTERN UNION.—Insiders, like Mr. Frank Gould, are said to be very bullish on Western Union, which they claim has not yet had an advance commensurate with the advances in other stocks. It is alleged that there is a plan whereby the Postal Telegraph Company will cast its interests with those of the American Telephone & Telegraph Company (the Bell) and arrange some sort of a working alliance. Such a combination as this, it is argued, would force the Western Union to adopt counter measures. In short, Western Union would probably close with the independent telephone interests. Experts agree that such an array of competitive forces would be of immense advantage to the Western Union. Another rumor talks of a Bell guarantee. Some of them, whose information on the stock has been good heretofore, say they have no knowledge of any deal whereby Bell Telephone would guarantee 6 per cent or upwards on the stock. If it were true they would be likely to know something of it. President Chandler, of the Postal, and President Eckert, of the Western Union, do not know of any negotiations whatsoever.

CONSOLIDATION AT PORTLAND, ME.—The Cumberland Illuminating Company, Sebago Power Company and Deering Electric Light Company, all of Portland, Me., have been consolidated under the charter of the Cumberland Illuminating Company, and the combined corporations have adopted the name of Portland Lighting & Power Company. The Company bearing this name and controlled by the same interests is also to be absorbed by the new company. The Portland Lighting & Power Company is capitalized as follows: Stock, preferred, $100,000; stock, common, $250,000; bonds, $350,000. The officers of the Portland Lighting & Power Company are as follows: President, J. R. Libby; vice-president, M. H. Kelly; treasurer and manager, E. H. Mather.

BOSTON LIGHTING CONSOLIDATION.—We are authoritatively informed that large interests identified with the Edison and Boston electric light companies have agreed to a consolidation. Under the terms of agreement the Edison Company is to absorb the Boston Company, and issue new Edison shares in exchange. It is understood that the basis of exchange agreed upon is 10 Edison shares for 11 Boston shares. Formal action has not yet been taken by the boards of directors of the two companies, and probably will not be taken until the permissive bill now before the manufacturers' committee of the Massachusetts Legislature has been acted upon by that committee.

DIVIDENDS.—The New England Telephone & Telegraph Company has declared a regular quarterly dividend of $1.50, payable May 15. Directors of the N. Y. & N. J. Telephone Company have declared a regular quarterly dividend of 1½ per cent, payable April 15. The Louisville City Railway has declared a semi-annual dividend of 2½ per cent on its preferred stock, and a quarterly dividend of 1 per cent on the common stock, payable May 1.

MORTGAGE.—A $20,000,000 mortgage given by the United Electric Company, of New Jersey, to the New Jersey Title & Guarantee Company has been filed recently in the Essex County Register's Office at Newark. The lien is to guarantee the first mortage bonds issued by the company to take the place of collateral trust bonds outstanding.

ILLINOIS ELECTRIC VEHICLE.—A statement comes from Chicago that the management of the Illinois Electric Vehicle Transportation Company has received more than enough proxies from stockholders to carry through the plan to liquidate the concern.

ERIE TELEPHONE DIVIDEND.—Erie Telephone directors have deferred dividend action pending the examination of the company's books by the Eastern auditors. Three months ago the regular quarterly dividend of 1¼ per cent was declared.

THE TRUCKEE RIVER GENERAL ELECTRIC COMPANY, Floriston, Calif., paid its regular monthly dividend of 10 cents per share on March 20.

Commercial Intelligence.

THE WEEK IN TRADE.—In reviewing trade conditions, *Bradstreet's* notes that there is a rather more cheerful tone in general trade and the close of the first quarter of the year finds the business world contemplating a total trade for that period in many cases in excess of all preceding periods, while the future, with some exceptions, is viewed with apparent hopefulness. The advance of the spring season is partly responsible for this feeling, allowing, as it does, better opportunity for a wider range of operations than is possible in the winter months. Railway earnings testified to an immense volume of merchandise passing into consumption, more than has for some time past. The active demand at advancing prices for iron and steel is regarded as a reliable index of the general trade to come. Building is becoming more active and promises this spring to be the heaviest for many years past. Western trade advices are relatively most favorable, Chicago, St. Louis and Kansas City being notable as reporting business for the first quarter larger than a year ago. The labor situation is more tranquil, and mining differences in the soft coal region are settled. Railroad earnings in three weeks of March show an increase of 10.2 per cent over the same period last year and 33.2 over the same period in 1899. The failures for the week as reported by *Bradstreet's*, number 189, against 231 the week previous and 178 the corresponding week last year. *Dun's Review* computes the liabilities for the four weeks of March at $8,134,731, against $10,349,796 the corresponding week last year. In the copper market there is no change of note; the demand is still rather light and prices are held to the nominal figure of 17 cents for Lake and 16⅝ cents for electrolytic. These prices are, however, admittedly artificial. The reports are showing up less favorably than was expected. Thus far this month only 5600 tons were sent out, while 2600 tons arrived.

TRACTION IN MEXICO.—The prosperous City of Merida, capital of Yucatan, Mexico, will shortly have a modern electric traction system. There is at present operated in that city and its immediate surroundings some 50 miles of mule tramways. It will be recalled that the contract for the electric lighting of Merida was recently awarded to the Siemens & Halske Company, the German concern which installed the City of Mexico electric lighting plant. The power house, etc., for the projected road will, it is estimated, mean an expenditure of some $200,000. Certain New York bankers, who have largely financed various industrial enterprises in that part of the world, have already been approached with a view to their securing a financial interest in the scheme. The City of Mexico Tramways Company is about to make a purchase of 20 cars from the St. Louis Car Company. These cars will be of the most up-to-date build, and fitted with the most improved contrivances, and are to cost some $6,000 each. The Mexican company already operates five cars which were manufactured by the St. Louis concern.

THE DEEP LEADS ELECTRIC TRANSMISSION COMPANY, LIMITED, of 26 St. Swithins Lane, London, England, an English concern operating a transmission line for the purpose of working gold mines in the Moolart Mining Camp in the vicinity of Melbourne, Australia, is purchasing considerable equipment, etc., rendered necessary by an extension of the plant. J. G. White & Co., of London, who act as consulting engineers to the enterprise, have recently closed contracts, through their New York office, with the Lambert Hoisting Company, of this city, for the furnishing of four double drum electric mine hoists, each to be operated by 75-hp motors furnished by the General Electric Company. R. Poole & Son Company, of Baltimore, has obtained a contract for a gear train to be used for operating a Cornish pump. This machinery will weigh about 130 tons, and will constitute one of the largest equipments of the description ever shipped abroad.

THE AMERICAN BRIDGE COMPANY reports its foreign trade as developing very rapidly. Within the past few years it has received a contract for 20,000 tons of bridges for the Guayaquil & Quito Railroad Company in Ecuador, South America, and a large group of buildings for the Cananea Consolidated Copper & Silver Mining Company, of Mexico; and also several large contracts for manufacturing buildings to be shipped to Australia, and a large railroad bridge to go to the Sandwich Islands. It is also announced that its tender for a large foreign contract exceeding in size anything which it has taken has been accepted, and that one of its engineers sailed this week to consummate the arrangements. The officials of the American Bridge Company decline to say anything about this matter until the contract is definitely consummated, but admit the facts substantially as above stated, that it is the most important foreign contract that it has yet taken.

THE AMERICAN VITRIFIED CONDUIT COMPANY, of New York City, has been awarded the contract for the supplying of conduit to be utilized by the Charing Cross & Hampstead Underground Road, London. Some 500,000 ft. of material have been requisitioned. J. F. Cummings, the general manager of the European division of the American Company's business, with headquarters in London, sailed for the other side last Wednesday by the St. Louis. One of the company's engineers accompanied him for the purpose of superintending the laying down of the conduit. Mr. Cummings feels assured that the important contract for the furnishing of conduit to carry telephone wires between Brussels, Lille and Antwerp will be placed in the United States. The project is being carried out by the Belgian Government, and will mean the employment of fully 3,500,000 ft. of conduit. A decision is expected to be arrived at as regards the awarding of the Belgian contract within the next few days.

THE AMERICAN ELECTRIC TELEPHONE COMPANY reports that it has recently installed additional central energy switchboards in the following places: Bowling Green, Ohio, 150 drops; Salem, Ohio, 100 drops; East Liverpool, Ohio, 100 drops; Wellsville, Ohio, 100 drops; Rome, N. Y., 125 drops. Among the recent orders for switchboards filled by the American Company during the past week are Nelsonville, Ohio, 200 drops; Hartford City, Ind., 400 drops; Mt. Pelier, Ohio, 200 drops; Manning, Ia., 100 drops; Nicholasville, Ky., 300 drops; Timpsonville, Texas, 150 drops; Logan, Ia., 200 drops; Bluffton, Ind., 300 drops. In addition to the above it has closed for several very important installations for both central energy and express type switchboards. The company reports that it has experienced a large increase in business since the Berliner decision.

THE ELECTRIC STORAGE BATTERY COMPANY, of Philadelphia, has recently closed a contract with the Hamilton, Grimsby & Beamsville Electric Railway Company, of Hamilton, Ontario, for the installation of a battery of chloride accumulators at Grimsby, a point 10½ miles from their power house. The installation consists of 229 elements to give a discharge rate of 160 amperes, and is to be used to regulate and maintain the voltage on the line. The containing jars for this battery are sufficiently large to allow a future increase of 50 per cent upon the addition of extra plates.

ELECTRIC RAILWAYS IN SWEDEN.—Consul Bergh transmits from Gothenburg, March 16, 1901, blue prints and specifications calling for bids from manufacturers desiring to furnish rails, switch and cross frogs, and electric cables for the electric street railroads to be built in Gothenburg. The bids must be delivered to the street railroad office in that city not later than on April 10, 1901, and the time is too short to have the specifications translated. They are on file in the Bureau of Foreign Commerce, where they may be consulted by interested parties.

THE J. P. McDONALD COMPANY, of New York City, contractor for the construction of the Guayaquil & Quito Railroad, Ecuador, South America, has just awarded a contract for the supplying of 400 miles of telegraph wire to a European concern. A representative of the contracting concern says that our competitors on the other side quoted a lower price for the wire delivery in South America than the closest American bidder offered the material f. o. b. New York. Delivery is to be made inside of 60 days from date of contract.

THE AMERICAN SUGAR REFINING COMPANY, through its electrical engineer, Mr. Holmes, has closed a contract with the Bullock Electric Manufacturing Company for the building of two 750-kw generators, several motors of various sizes and a quantity of miscellaneous electrical machinery, etc., to be installed in the Williamsburg plant. The value of the contract is said to be $25,000 approximately.

NEW ELECTRIC PLANT FOR CINCINNATI.—Mr. J. A. Kammerer, an electrical engineer of Toronto, Canada, says he represents a syndicate of wealthy Canadians who have subscribed $1,500,000 toward the erection of a large electric plant in Cincinnati, Ohio. Cincinnati parties are said to be interested to a like amount. Mr. Kammerer expects to return to Cincinnati about the second week in April.

STANLEY PEACH, electrical engineer, of 28 Victoria Street, London, S. W., is, according to private advices, about to make some important awards regarding the furnishing of structural steel to be utilized in various power houses about to be constructed by various British traction concerns. The contracts will, it is said, involve an expenditure of fully $200,000 with American steel concerns.

THE PIERCE ELECTRO VEHICLE COMPANY will build an electric vehicle at Bound Brook, N. Y., where Dr. Pierce, of Buffalo, is already heavily interested in the American Engine Company. The concern has already built one electric delivery wagon, which is in use by the Denver *Times*.

NEW CARBON FACTORY.—Cincinnati capital may become interested in a large carbon factory in Weston, W. Va. The output of one factory in this gas belt (recently discovered) was 5400 lbs. of carbon, which was produced much more cheaply because of the natural gas facilities.

EXPORTS OF ELECTRIC MATERIAL—The following were the exports of electric material from the port of New York for the week ended March 20: Antwerp—6 cases motor carriages, $997; 34 packages electrical material, $3,285. Alexandria—1 package electrical machinery, $78. British East Indies—8 packages electric material, $287; 11 packages electrical machinery, $7,765. Brazil—212 packages electrical material, $14,137; 50 cases electrical machinery, $4,747; 1 case electros, $50. Bremen—3 packages electrical material, $110. British Australia—1 package electrical material, $25. All other British Possessions—1 case electrical machinery, $125. British West Indies—56 cases electrical material, $1,411; 1 case electrical machinery, $45. Central America—667 packages electrical material, $6,909; 3 packages electrical machinery, $401. Cuba—96 cases electrical material, $7,286. China—9 packages electrical material, $322. Dutch West Indies—23 packages electrical material, $718. Frankfort—1 case electrical material, $150. French Possessions in Africa—94 cases electrical material, $12,350. Genoa—48 packages electrical material, $16,255. Havre—43 packages electrical material, $2,250; 33 packages electrical machinery, $3,125. Hayti—58 packages electrical material, $381. Hamburg—3 packages electrical machinery, $2,339; 40 packages electrical material, $2,705. Japan—49 cases electrical material, $17,414. Korea—66 cases electrical machinery, $14,207. Lisbon—30 packages electrical machinery, $30,876; 54 electric cars, $112,006. Liverpool—201 packages electrical machinery, $8,500; 316 packages electrical material, $6,694; 3 packages auto vehicles, $920; 241 packages electrical machinery, $17,189. London—24 packages motor vehicles and parts, $6,000; 208 packages electrical material, $10,563. Marseilles—45 cases electrical material, $2,702. Mexico—798 packages electrical material, $7,011. Newcastle—4 packages electrical machinery, $400. Newfoundland—20 packages electrical material, $586. Nova Scotia—92 packages electrical material, $865. The following were the exports of electrical material and apparatus from the port of New York for the week ended March 27: Antwerp—5 packages electrical material, $384. Alicante—8 packages electrical material, $1,347. British Possessions in Africa—2 cases electrical machinery, $75; 110 packages electrical material, $12,701; 3 cases motor vehicles, $925. Barcelona—12 packages electrical machinery, $573. Brazil—14 packages electrical material, $1,296. Bournemouth—1 case electrical machinery, $700. British East Indies—19 packages electrical material, $1,116. British Guiana—4 packages electrical material, $38. British West Indies—9 packages electrical material, $201. British Australia—6 cases electrical material, $314. Central America—13 packages electrical material, $916. Christiania—1 package electrical machinery, $300. Copenhagen—6 packages electrical machinery, $90. Cuba—175 packages electrical material, $4,589. Chili—9 packages electrical material, $434. Ecuador—5 packages electrical material, $60. Glasgow—75 cases electrical machinery, $13,184; 172 cases electrical material, $23,072; 73 reels electrical cable, $28,376. Genoa—1 package electrical machinery, $20; 36 packages electrical material, $3,652. Hamburg—14 packages electrical machinery, $2,463; 69 packages electrical material, $4,197; 58 cases electric material, $2,825; 29 cases electrical machinery, $7,611. Liverpool—77 packages electrical machinery, $11,834; 24 packages electrical material, $1,035. Leith—3 packages electrical material, $178. London—225 cases electrical machinery, $9,906; 57 packages electrical material, $4,404; 4 packages motor vehicles, $1,930. Liecester—2 cases electrical material, $230. Milan—6 cases electrical material, $269. Mexico—30 cases electrical material, $1,478. Manchester—1 package electrical material, $375. Newcastle—90 packages electrical machinery, $48,677. New Zealand—1 package electrical material, $28. Naples—2 cases electrical material, $285. Preston—1 package electrical material, $25. Peru—15 cases electrical material, $242. Rotterdam—7 cases electrical material, $74. Sheffield—16 cases electrical machinery, $2,000. Southampton—1 case electrical machinery, $500; 2 packages electrical material, 101. St. Petersburg—2 packages electrical machinery, $150. United States of Colombia—205 cases electrical material, $1,075; 2 reels cable, $29. Venezuela—139 cases electrical material, $738. Zurich—1 case electrical machinery, $70.

THE TOTAL EXPORTS for the eight months ending with February, 1901, show an increase of more than $95,000,000 over last year, but those of manufactures alone show but a slight increase, and there is reason to believe that the recorded total of manufactures for the full fiscal year will fall somewhat below that of the preceding year. This is due to the fact that a large proportion of exports to China are manufactures, and that the apparent reduction, in the Hawaiian and Porto Rican figures relates almost exclusively to the class of exports designated as manufactures. Another condition which has a tendency to reduce the total value of exports of manufactures is found in the fact that prices of manufactured articles in many cases have fallen because of the reduction in the cost of the raw material from which they were produced, and that the exportation of an equal or even greater quantity supplies a smaller figure in the statement of values by which the export movement is necessarily measured. It is quite probable, in view of the facts above outlined, that the record of exports of domestic manufactures in the fiscal year 1901 may show an apparent reduction, though the fact that more than $20,000,000 worth of actual shipments from our ports which were formerly counted as foreign commerce no longer appear in these statements will account for the reduction, which will thus be more apparent than real.

THE CROCKER-WHEELER COMPANY, Ampere, N. J., reports that the orders booked for the month of March exceed by a considerable percentage the largest manufacturing business which the company has had at any time during its previous history. Among the more important contracts which have been closed are the following: Philadelphia Engineering Works, 500 horse-power in crane motors; Messrs. Witherbee, Sherman & Co., one 150-kw belted type generator, and 160 horse-power in motors; General Electric Company (1900), Limited, Glasgow, Scotland, one 150-kw belted type generator; Newport News Shipbuilding & Dry Dock Company, two dynamotors, one bipolar dynamotor, one dynamotor; the New United States Mint at Philadelphia, 19 motors aggregating 115 horse-power; Newton Street Railway, Newton, Mass., one engine type, 400-kw railway generator; the Guggenheim Smelting Works, Perth Amboy, N. J., two engine type, 520-kw electrolytic generators; Alsen's American Portland Cement Company, of West Camp, N. Y., three engine type, 4[illegible]-kw power generators, and one engine type, 100-kw lighting and power generator, also 43 motors aggregating 2000 horse-power; Brandywine Traction Company, Brandywine, Pa., one engine type, 200-kw railway generator; John B. Stetson Company, Philadelphia, Pa., two engine type, 300-kw lighting and power generators; Western Union Telegraph Company, 36 machines for telegraphic work.

ACTIVE DEMAND FOR ELECTRICAL APPARATUS.—The Bullock Electric Manufacturing Company reports an increased demand for electric machinery, principally for power equipment. Among orders of the past week are the following: The American Sugar Refining Company, of Brooklyn, one 20 and one 50-hp, type N motors; Beaman & Smith, Providence, R. I., one 5-hp and one 6-hp, type N, motors, direct connected, and one of 9-hp direct connected; H. Y. Cyphers, Pittsburg, 150-kw engine type generator; St. Louis Electric Supply Company, 150-kw engine type generator; Armour & Co., Chicago, four 100-hp type H motor, slow speed; American Tin Plate Company, Pittsburg, one 100-kw engine type generator; United States Printing Company, Cincinnati, two 25-hp and two 7½-hp type H motors; Charles H. Beardsley, Chicago, one 8-hp type N motor for direct connection with grinder; National Casket Company, Allegheny, two 6-hp and one 25-hp type N motors; Charles Kaestner & Co., Chicago, 11-hp elevator motor; Newton Machine Tool Company, Philadelphia, one 4-hp and one 1½-hp and two 5-hp type N motors; Fore River Engineering Company, Weymouth Mass., four 8-hp motors, type N (tenth order), and the Fisher Foundry & Machine Company, Pittsburg, 3 or 4 machines for a small multiple voltage plant.

BALL ENGINE ORDERS.—The Caxton Building Company, of Cleveland, Ohio, has recently installed an engine for its electric light plant. The engine is of the self-oiling type, built by the Ball Engine Company, Erie, Pa. Among recent installations by the Ball Engine Company of engines for electrical purposes are the following: Marion Steam Shovel Company, Marion, Ohio, 115-hp engine; Kentucky Wagon Manufacturing Company, Louisville, Ky., 125-hp direct-connected engine. Among other recent installations by the Ball Engine Company of its engines for electrical purposes are the following: Pittsburg Plate Glass Company, Cincinnati, Ohio, 125-hp direct-connected engine; Texas & Pacific Coal Company, Thurber, Texas, one 150-hp direct-connected engine; American Clay Working Machinery Company, Willoughby, Ohio, one 175-hp direct-connected engine.

THE ELECTRIC VEHICLE COMPANY, of Hartford, Conn., report that it has received contracts for carrying the Pan-American Exposition mails, and for distributing books from the Congressional Library. For these services it will use its Mark XI delivery wagons, which have a carrying capacity of 1000 lbs. beside the driver and attendant. For the mail service the vehicle will be required to cover 60 miles a day. The service will begin April 15. The vehicle will be painted black, with the Government seal on each side.

BLISS IN ITALY.—The E. W. Bliss Company, of Brooklyn, says that owing to its increasing European business it has found it necessary to open a branch at Viale Monfort, Milan, Italy. Bliss punches, presses, etc., are known and in widespread use throughout England and the Continent.

QUEENSLAND, AUSTRALIA.—The Westinghouse Electric & Manufacturing Company has been awarded by the Railroad Commissioner of Queensland a contract to furnish a complete electrical equipment for a new railroad shop at Ipswich. It is said that this will be a large order.

MONTREAL STREET RAILWAY COMPANY is at present making considerable purchases of equipment in this market. The Bullock Electric Manufacturing Company is said to have obtained a contract calling for six 500-kw motor generators.

Special Correspondence.

ENGLISH NOTES.

London Office of Electrical World and Engineer.
March 25, 1901.

AUTOMOBILE EDUCATION.—In order that the chief constables of England may have a more intimate knowledge of the automobile and its ways, and so be in a position the better to judge of the proposal to limit the rate of speed and label each vehicle, a number of these officials have been taken out for runs by the Automobile Club. Some of the chief constables and members of the executive council of the County Councils Association were taken out to Sheen House, Richmond, others being taken for educational purposes through certain of the busiest thoroughfares of the city. In this practical way the question of speed was studied, and interesting and instructive demonstrations of starting, stopping and turning were given by the various drivers. The chief constables met in conference the committee of the Automobile Club. The chairman was Mr. Roger Wallace, the president of the club. A number of the constables spoke upon the question for increased facilities for identification, the unanimous opinion being that some sort of distinguishing number or mark was absolutely necessary for the detection of the callous "scorcher." The best suggestion, according to the chairman, was that automobiles owned by members should bear the club's monogram, and that outside owners should carry numbers.

INDIAN POWER TRANSMISSION—The remarkable scheme for working the Kolar gold mines of Mysore by electricity transmitted from the falls of the Cauvery (Kavari) River has now assumed a practical shape, Captain de Lotbiniere, R. E., having visited England and the great Niagara works in America. Colonel D. M'Neill Campbell, chief engineer of the Mysore Public Works Department, has isued his complete report. The works are now designed and contracted for, to transmit over a distance of ninety miles 4000 horse-power, with extensions to Bangalore afterwards. All the parties have agreed—the British Government, which has water rights over the falls; Messrs. Taylor & Sons, of London, who represent the gold companies, and the Prime Minister of the Hindu State of Mysore, Sir K. Sheshadri Iyer, with whom is Colonel Robertson, C. S. I., the British Resident. Captain de Lotbiniere has been guided by a reference committee of such experts as Professors Forbes and W. C. Unwin, and Captain J. Thomson, late R. A. American, Swiss and German manufacturers have tendered, with the result that the works will be carried out by the General Electric Company, of America, and by Escher, Wyss & Co., of Switzerland, for the hydraulic plant. The total cost is estimated at £287,391, and the net income after all deductions at 10.2 per cent. The Mysore Government calculates on a total profit in the first ten years of more than half a million sterling, and the mines on saving £572,000 in working expenses. The scheme is the most magnificent, thus far, in the early annals of practical power. Its development is being watched by those interested in utilizing the cataracts of the Nile and the Zambezi.

ELECTRIC LIGHTING IN LONDON.—An important inquiry has been opened by the Board of Trade at the Westminster Town Hall in reference to the application made by the various electric lighting companies in London for an alteration of the proviso to Clause 6, Section B, of the regulations made by the Board on the 4th of March, 1896, for the efficient supply of electrical energy to consumers. The companies in general, in their desire to increase the carrying capacity of the electric lighting mains, have been engaged for some time past on the work of changing over the pressure of supply to consumers from 110 volts to 220 volts for the purpose of obviating further large capital expenditure on new mains, extending the scope of supply and avoiding the necessity for again opening the carriageways and footpaths to the inconvenience of the public. Unfortunately for the companies, some of the consumers have refused to accept a supply at the increased pressure, nothwithstanding that the former have agreed to undertake all the expenses incidental to the change of lamps and alterations of fittings where necessary, and have, it is believed, also offered a certain reduction in price. The result has been that a few obstinate customers have been able to disorganize the supply on the particular distributing system affected, and as the alteration to the increased pressure can, according to the proviso referred to, at present only be carried out with the consent of the consumers, the position of the companies has been rendered somewhat difficult. With a view to remedying the situation the Westminster Electric Supply Corporation has organized the other electric lighting companies in London for the purpose of presenting their case to the Board of Trade, and in this direction they have received the support of some, if not all, of the metropolitan borough councils which operate municipal electric supply works. The view of the companies and authorities is that the above-mentioned proviso, which requires the consent of consumers, should be so altered that failing an agreement between the companies and comsumers, the question of a change of pressure shall be referred to the Board of Trade, which, it will be contended, should appoint an arbitrator to finally settle the differences.

General News.

THE TELEPHONE.

MT. OLIVET, KY.—A five-mile telephone line is to be established from Mt. Olivet to Piqua.

KIRKWOOD, PA.—The Southern Telephone and Telegraph Company has been incorporated; capital, $10,000.

KANSAS CITY, MO.—The Terrace City Telephone Company has been incorporated with a capital stock of $500.

LOUISVILLE, KY.—The Louisville Home Telephone Company has been incorporated under the Delaware state laws.

MASSILLON, OHIO.—The Massillon Telephone Company has applied for a franchise to install an exchange in Canal Fulton.

ANSTELL, GA.—The Anstell Telephone Company has been chartered. J. H. Lauch and B. H. Veal, of Douglas county, are interested.

CUMBERLAND, MD.—The Woodford Telephone Company, of Elkins, W. Va., has applied for a franchise to construct a system here.

COLLEGE PARK, MD.—The Chesapeake & Potomac Telephone Company contemplates the establishment of a telephone system here.

VIENNA, OHIO.—Edward Hodge, of this place, is preparing to build a telephone line from Vienna to Plattsburg and is securing subscribers in both places.

LONDON, KY.—A. W. Huggins, of this place, is in the market for wire, brackets, insulator pins, etc., for construction of about seventy-five miles of telephone line.

FRENCH LICK, IND.—The Star Telephone Company of French Lick has been incorporated; capital stock, $2,000. Directors: L. Ellis, Harry Roland and J. L. Sutton.

BEDFORD, IND.—The City Council granted a franchise to the Carter Telephone Company, and Mayor Johnson vetoed it. The council promptly passed it over his veto.

PITTSFORD, N. Y.—This village will be equipped with a local telephone service by the Home Telephone Company of Rochester, whose line was recently put through here.

BLOOMDALE, OHIO.—The Central Union Telephone Company is establishing a rural telephone system among the farmers within a radius of five miles of this place.

WINDER, GA.—The North Georgia Telephone & Telegraph Company has been organized, and is in the market for supplies and equipment for the construction of a system.

PORTSMOUTH, OHIO.—The Ohio Telegraph & Telephone Company is constructing a direct line from Pittsburg to Cincinnati and has asked for a franchise through this place.

INDIANAPOLIS, IND.—Articles of incorporation have been filed for Scott County Telephone Company and the Sugar Creek Township Farmers' Telephone Company, of New Palestine, Hancock county.

INDIANAPOLIS, IND.—The Central Union Telephone Company and the New Telephone Company have each paid to the city treasurer the sum of $6,000 for the privilege of making use of the streets.

BISHOPVILLE, S. C.—The Bishopville Telephone Company, with a capital stock of $5,000, has been incorporated by W. S. Smith, of Smithville; Nat. Barrett, of Mannville, and J. E. McLure, of Bishopville.

JACOBSBURG, OHIO.—The Peoples Telephone Company, of this place, has been incorporated by W. G. Simpson, Miles R. Hart, G. C. Meek, P. W. Helpinger, and Albert McKelvey. Capital stock, $10,000.

POPLAR HILL, VA.—The Poplar Hill Telephone Company has applied for a charter to operate telephone plants in Giles and Pulaski counties, Va.; capital, $5,000. C. W. Shannon, R. L. King and others of Poplar Hill are interested.

NEW YORK, N. Y.—It is reported that the Knickerbocker Telephone & Telegraph Company is pushing construction work in the upper part of the city and towards Yonkers. The Company, it is stated, is centering its efforts in the Borough of the Bronx.

INDIANAPOLIS, IND.—Mr. Simon P. Sherin, vice-president of the New Telephone Company, says that "the telephone business is such a good profit earner that moneyed men are casting about the country trying to finance weak and penniless companies."

WINTHROP, MINN.—The People's Telephone Company has been organized here by the business men. The officers are: President, R. R. Stoner; vice-president, C. M. Peterson; secretary, J. A. Larson; treasurer, C. A. Benson. The capital stock is $10,000.

CLINTON, N. Y.—The Clinton Telephone Exchange has a 100-drop Stromberg-Carlson board and one hundred subscribers. The company is expecting to build several toll lines in the near future. With its connections, it reaches 5000 subscribers in Central New York.

RAVENNA, OHIO.—The Ravenna Home Telephone Company has decided to increase the capacity of its exchange and cables and switchboard will be added to accommodate 500 subscribers. About 3000 feet of cable will be strung. At present the company has 400 subscribers.

DAYTON, OHIO.—The Board of City Affairs has again recommended an ordinance granting a franchise to the Dayton Home Telephone Company and the City Council after investigating the matter has adopted a resolution asking the Probate Judge to assume his prerogative and grant the franchise.

BICKNELL, IND.—The Independent Telephone Company, organized by Bicknell and Vincennes parties, will erect an exchange here at once. The company has arranged with the Central Union Company to furnish long distance service over the toll lines of that company. It will also build lines to all surrounding villages.

RICHMOND, VA.—The Southern States Telephone Company has filed a deed of trust at Norfolk, Va., to the Fidelty Deposit Company, of Baltimore, to cover $50,000 previously borrowed and $100,000 for improvements now begun. The company will soon be connected with the principal cities of Virginia by connection with the Long Distance Telephone Company of Virginia.

MANSFIELD, OHIO.—The Farmers' Co-operative Telephone Company which covers the rural districts of Ashland, Knox, Richland, and Morrow Counties, has made an assignment to Archibald H. Brown, of Bellville. The company has a capital stock of $10,000. The liabilities are between $8,000 and $10,000, and the assets about $4,500. E. E. Shafer is president of the company and E. R. Leedey secretary.

CLEVELAND, OHIO.—The directors of the Federal Telephone Company have effected a deal for the sale to an underwriting syndicate composed of local people of practically the entire issue of the bonds of the Cuyahoga Telephone Company. The holders of the bonds have been asked to turn them in at $87.50, less 2½% commission. Some of the bondholders deem $85 too low and have declined to sell at that price.

FT. WAYNE, IND.—A telephone deal of considerable magnitude was completed here last week, whereby the stockholders of the Home Telephone Company, of Ft. Wayne, purchased from the Telephone, Telegraph & Cable Company, of New York, all the interests represented by the National Telephone Company, for $120,000 cash. The National company has 1100 miles of wire, connecting Sturgis, Mich.; North Baltimore, Ohio; Auburn and Kendallville, Ind., and numerous intermediate points with this city.

AUSTIN, TEX.—The charter of the Bell County Telephone Company has been filed in the Secretary of State's office. The capital stock of the company is $120,000, and its headquarters are at Temple, Tex. The stockholders are for the most part the same men who compose the other independent telephone companies in Texas. The incorporators are: James King Duffy, of New York City; James S. Brailey, of Wauseon, Ohio; Z. B. Campbell, of San Antonio, Tex.; C. N. Haskell, of Ottawa, Ohio; J. B. Earle and J. E. Boynton, of Waco, Tex.; H. M. Daugherty, of Columbus, Ohio.

TERRE HAUTE, IND.—The American Electric Telephone Company reports that the central energy switchboard being installed by it for the Citizens' Telephone Company, at Terre Haute, Ind., is rapidly nearing completion, and that it is expected that operation will be commenced shortly. The American Company is equipping this exchange complete in every respect and says that it will be one of the finest equipments of central energy switchboards ever installed by an independent company. The Raleigh Telephone Company, of Raleigh, N. C., has a similar switchboard, and according to the latest reports the equipment is giving excellent service.

AUSTIN, TEX.—The independent telephone movement is having a rapid growth in Texas. The latest company of this character to be organized for business in this State is the Grayson County Telephone Company, with headquarters at Sherman, Tex. It has a capital stock of $150,000. Its purpose is to build and operate a telephone system in Grayson county, including the cities of Denison and Sherman. The incorporators are: James S. Brailey, of Wauseon, Ohio; W. A. Armstrong and F. B. McElroy, of Sherman, Tex.; R. S. Legate, of Denison; Z. B. Campbell, of San Antonio; James King Duffy, of New York City, and C. N. Haskell, of Ottawa, Ohio.

SAN ANTONIO, TEX.—The San Antonio Telephone Company, which recently established an independent exchange here in opposition to the Southwestern Telegraph & Telephone Company, now has about 650 instruments in operation, and this number will be increased to about 1500 on the arrival of additional cable, which has been ordered. It is announced that the San Antonio Telephone Company, in connection with the several other independent exchanges of the State, including those of Houston, Austin, Waco, and a number of smaller towns, will soon be connected by long distance wires. Preliminary to starting the work of constructing these long distance lines in Texas, a number of general officers of the National Contracting Company, whose headquarters are at Cleveland, Ohio, and who are in charge of the independent telephone construction work in this State, have arrived at San Antonio. In the party are James L. Brailey, general superintendent; W. H. Harper, Jr., treasurer; C. N. Haskell and H. N. Daugherty, of the executive committee, and James King Duffy, vice-president. It is stated by General Superintendent Brailey that there has been considerable delay in the construction of the San Antonio and other independent telephone systems in Texas on account of the non-arrival of much-needed material from Eastern factories. These factories are said to be far behind their orders in turning out construction material.

ELECTRIC LIGHT AND POWER.

STURGEON BAY, WIS.—The city contemplates building an electric lighting plant.

JACKSON, GA.—The Pepperton Cotton Mills are installing an electric light plant.

SPOKANE, WASH.—Wenatche, Wash., is about to order an electric light plant.

VAN BUREN, ARK.—The Van Buren Electric Light & Power Company has been sold out.

YORKTOWN, TEX.—The citizens of Yorktown will erect an electric light and ice plant at a cost of $8,000.

GLACE BAY, C. B.—The Town Council will likely install an electric light plant during the coming summer.

BURNSIDE, KY.—The Burnside Electric Light & Power Company has been chartered, with a capital stock of $4,500.

TWO RIVERS, WIS.—At a recent election it was voted to issue $20,000 in bonds for an electric light plant and waterworks.

SHEFFIELD, ALA.—H. Habler has applied for a franchise for the construction of a $75,000 electric light plant and waterworks.

EL PASO, TEX.—The Southern Electric Company, capital stock $10,000, has been organized by B. L. Berkey, G. A. Andrews and others.

BRISTOL, TENN.—It is proposed to issue bonds for $25,000 for the construction and equipment of an electric light plant in this city.

WINCHESTER, TENN.—Bonds to the amount of $30,000 have been voted by the citizens of this place for an electric light plant and waterworks.

OTTAWA, ONT.—A by-law to provide for the installation of an electric light plant for the town of Thessalon, Ont., will be submitted to the ratepayers on May 6.

BUTLER, MO.—The City Council has decided to submit a proposition to the voters at the election to issue $20,000 bonds for the purpose of building an electric light plant.

FRANKFORT, KY.—The Union Light, Heat & Power Company, of Covington, filed articles of incorporation with the Secretary of State. The capital stock is $1,500,000.

WHEELING, W. VA.—The Wheeling & Elm Grove Railway Company has absorbed several electric light and street railway properties in this city and will issue $1,250,000 bonds.

COOPER, TEX.—The Cooper Electric Light Company, with capital stock of $10,000, has been incorporated by Charles Tuttle, Wm. R. Evans and Ed. S. Kelley, of Kaufman, Tex.

THE KERO ARC LIGHT COMPANY has been incorporated in New Jersey to manufacture lamps; capital, $300,000. Incorporators: Wiliard B. Mack, E. H. Fessenden and J. F. Place.

CINCINNATI, OHIO.—After the expiration of the present electric lighting contract there will be no gasoline lighting in this city. No gasoline lamps will be considered in the new contract.

SAN FRANCISCO, CALIF.—City Engineer Grunsky, of San Francisco, recently filed an elaborate report on a projected municipal electric lighting plant. The estimated cost of operation is about $242,000 per year.

ATCHISON, KAN.—The Atchison, Railway, Light, Heat, Power & Water Company, capital $800,000, has been incorporated. Incorporators: B. P. Waggener and W. P. Waggener, J. A. Bendure, all of Atchison..

GREAT FALLS, MD.—It is stated that a Great Falls Power Company will expend $2,000,000 in establishing a power transmission plant at Great Falls, on the Potomac River. The company's headquarters are in Washington.

HALIFAX, N. S.—The City Council has decided to establish a municipal electric plant, and thus enter into active competition with the Halifax Electric Tramway Company. The estimated cost of a suitable plant is placed at $100,000.

CINCINNATI, OHIO.—The Board of Public Service of this city has approved resolutions ordering electric lights in the middle of squares in the heart of the city. Hitherto they have been placed at intersections of streets only.

CINCINNATI, OHIO.—The Cincinnati Edison Electric Company has purchased property on Central avenue, on which will be erected at once a new power station with a frontage of 340 feet. The new plant will be equipped with new engines of 5000 horse-power.

CLINTON, IA.—The Clinton Gaslight & Coke Company is inviting bids on second-hand machinery in first-class condition for the equipment of an electric light plant. One engine, one alternator, arc lamps and a full line of material are specified for delivery in Clinton.

BLOOMINGTON, IND.—The Bloomington Light, Heat & Power Company has closed a contract with the Lakon Company, of Elkhart, Ind., for transformers of 5000-light capacity to replace those now in service. The company will expend $25,000 for improvements to its system.

SAN FRANCISCO, CALIF.—The electric lighting station in Petaluma, Calif., will soon discontinue the use of coal as fuel, and a 15,000-gallon cemented tank is being constructed to hold a supply of petroleum oil. This will be the second trial of oil fuel at this plant, and the estimated reduction of expenses is 10 per cent.

BLOOMFIELD, IND.—An electric light and power company is to be incorporated here with a capital stock of between $10,000 and $20,000. The principal incorporators will be: E. H. Dugger, Jonas E. Meredith and Will B. Maddock. The company will need an entirely new equipment. Nothing has as yet been purchased.

READING, PA.—The mayor has signed a bill granting a franchise to the People's Light & Power Company, of Reading, to establish a plant and system in this city. The company will soon be reorganized and its capital stock increased to $100,000. Plans will then be drawn up for the erection of a plant, and contracts awarded.

SAN FRANCISCO, CALIF.—The California Central Gas & Electric Company has been incorporated by John Martin, Fred H. Pierson and H. U. Roeding, of San Francisco, and John A. Britton, of Oakland. Capital stock, $1,500,000. The company will carry on its operations in Sacramento, Butte, Marin, Napa and Sonoma counties.

SANDERSVILLE, GA.—Messrs. Holt & Brother are organizing an electric light company and are now in the market for electrical equipment for the same. They propose to install a plant with a capacity of about 35 arc lights and 1000 incandescents. About 60 per cent of this total capacity, it is stated, will be required at the start. The company's capital is $30,000.

NEW ALBANY, IND.—The Commercial Club, of this city, and business men of Louisville, have revived the project to utilize the immense water power of the falls of the Ohio River at this place. It is claimed there is power enough to run the street railways, electric light plants and all the factories of Louisville, New Albany and Jeffersonville. Steps are being taken to devise a plan of operation.

SPRINGFIELD, MO.—The City Council will give a 20-year electric light franchise. A gas franchise will also be included. One hundred and eighty arc lamps will be required, and the city will give a seven-year contract. The present company has no franchise or contract with the city. There is a good opening for 7000 incandescent lights in this city, which has a population of 30,000 inhabitants.

CHARLOTTE, N. C.—A representative of C. C. Howell and associates, of Knoxville, Tenn., will visit Charlotte, N. C., and endeavor to make contracts to supply electric power to be transmitted from Motts' Shoals, thirty miles distant. It is stated that the Howell company is making arrangements to harness Motts' Shoals, and if the project succeeds, it will be prepared to furnish other towns with electric power.

TRENTON, N. J.—The Federal Water Power & Cable Company, capital $1,000,000, has been incorporated to construct public works of all kinds, including railroads, wharves, water works and electric light works. Incorporators: John W. Avery, Osborn Congleton, New York; A. J. Ream, P. W. Masten,

Hugh C. Brady, all of Kansas City; J. A. Hill, Enid, Okla.; Walter Grieg, Joplin, Mo.; H. G. C. Thornton, Cranford, N. J.

SNOHOMISH, WASH.—The City Council have entered into a contract with E. S. Aldrich, J. B. Brown and O. Lewis, composing the Snohomish Electric Company, to pump the city water and light the streets for a period of five years, beginning August 1, 1901. The present light plant will be rebuilt at the city pumping plant and changed to the alternating current system. About a 150-hp. engine and 75-kw. alternator will be installed, as well as wire, transformers, enclosed arcs, etc. The company also contemplates installing a plant at Arlington, Wash. E. S. Aldrich is manager.

THE ELECTRIC RAILWAY.

BELLEVUE, KY.—An electric railway is to be built between this place and California, Ky., a distance of three miles.

NEW CASTLE, IND.—The work of surveying the route of the New Castle & Muncie Interurban Electric line is completed.

DALEVILLE, IND.—The Union Traction Company will soon begin the construction of a line from here to Middletown.

CANTON, OHIO.—The Canton-Massillon Electric Railway Company has applied for a franchise in the village of Navarre.

APPLETON, WIS.—The Fox River Valley Electric Railway Company has completed arrangements for the rebuilding of the entire local line.

CINCINNATI, OHIO.—The new traction company, an outgrowth of the Consolidated Street Railway, will erect a large central power house.

MARION, OHIO.—The Marion, Green Camp & Prospect Electric Railway Company has secured a franchise from the County Commissioners.

EAST LIVERPOOL, OHIO.—A company headed by E. H. Hill is securing right of way to build an electric railway from this city to Chester and Congoe, W. Va.

GUELPH, ONT.—The Guelph Railway Company has secured a charter to construct an electric railway to Hespeler, via Puslinch Lake, and also to Berlin, Ontario.

MARYSVILLE, OHIO.—The Union Electric Railway Company has been granted a twenty-five year franchise to operate three separate lines over certain pikes in Union County.

SPRINGFIELD, OHIO.—After a fight against three rival lines, the Little Miami Traction Company has secured a franchise through Springfield for its road to Xenia and Cincinnati.

RICHMOND, VA.—The Richmond & Petersburg Electric Railway Company has had plans made by B. W. Poindexter for its proposed $15,000 power plant to be erected near Manchester.

WORCESTER, MASS.—The Worcester and Blackstone Valley Street Railway is building a model power plant at Millbury. Among the up-to-date features will be a Green economizer.

JERSEY CITY, N. J.—The stockholders of the Consolidated Traction Company re-elected all the old directors with the exception of Henry Lembeck, who is succeeded by James E. Hulshizer.

CHARLESTON, W. VA.—The Ohio & West Virginia Interurban Railway Company has been incorporated; capital, $50,000. Incorporators: Eugene E. Grannan and four others, of Baltimore, Md.

NEW ORLEANS, LA.—It is announced that the St. Charles Street Railroad Company will build several extensions in the city. The company is considering an increase in its capital stock of $200,000.

ALBANY, N. Y.—Paul Smith and Wallace Murray are promoters of a plan to build a trolley line from Bloomingdale to Saranac Lake thence to Lake Placid, to Keene Valley and down the Ausable Valley to Keesville.

WARREN, OHIO.—It is said that a Philadelphia syndicate of street railway promoters will purchase sixteen franchises for trolley line routes through Ashtabula, Trumble and Geauga Counties, Ohio, and Crawford County, Pa.

KOKOMO, IND.—It is reported that contracts have been signed for the Indianapolis, Tipton, Elwood & Kokomo Electric Railway, and that the money is secured. S. Smithers & Co., bankers, of New York, will finance the project.

COLUMBUS, OHIO.—The Urbana, Bellefontaine & Northern Railway Company has been incorporated with $50,000 capital stock by J. H. Harshman, John G. Webb, C. W. R. Niven, Charles A. Alderman, Wm. T. Haviland and John Green.

JERSEY CITY, N. J.—At the annual meeting of the stockholders of the North Jersey Street Railway Company, Joseph D. Bedle and Edward L. Young were chosen respectively to succeed the late F. O. Matthiessen, and A. Q. Garrettson resigned.

CINCINNATI, OHIO.—The Cincinnati Traction Company's car barns at the head of Elm Street were destroyed by fire, entailing a loss of about $40,000. Sixteen new cars, some old rolling stock, paints and electrical supplies valued at $25,000 were destroyed.

OTTAWA, ONT.—An act incorporating the London, Aylmer & North Shore Electric Railway, of Ontario, has passed the railway committee of the Ontario Legislature. This road will run from London, Ont., to Aylmer and Port Burwell. Capital stock is $850,000.

AKRON, OHIO.—The Northern Ohio Traction Company is planning to increase the capacity of its power house here, in order to take care of extensions. Plans for the extension are being prepared and contracts for the equipment will be closed in the near future.

CLEVELAND, OHIO.—A Cleveland syndicate has purchased the Aurora Street Railway Company of Aurora, Ill., and the Aurora & Geneva Electric Railway Company. The two roads are to be consolidated with the Elgin City, Carpentersville and Aurora Railway.

NEWARK, N. J.—The stockholders of the Worcester Traction Company, of Worcester, Mass., voted to accept an offer from Vermilye & Co., of New York, for the company's stock, franchise and plant. The company operates fifty miles of track and has a capital of $5,000,000.

CINCINNATI, OHIO.—It is reported that capitalists back of the Little Miami Traction Company, in addition to building an interurban line between this place and Springfield, will run connecting lines to Columbus and Dayton, and build several roads in the southern part of the State.

COLUMBUS, OHIO.—The Lakeside, Napoleon & Western Electric Railway Company has been incorporated with $300,000 capital stock to build a line from Marblehead to Bryan, and probably to Montpelier, Ind. The promoters are Indianians, headed by G. H. Brown, of Fort Wayne.

NOBLESVILLE, IND.—The City Council has extended the time for the completion of the Indianapolis & Kokomo Electric line for one year. The road in financed by Smithers & Co., New York bankers, and the contract for construction has been awarded to J. G. White & Co., of New York.

SYDNEY, N. S.—The Cape Breton Electric Railway Company, of Sydney, will shortly commence construction of an electric tramway line between Sydney and Glace Bay. A representative of the company has gone to Boston, Mass., where all arrangements are being made for the building of the line.

FAYETTEVILLE, N. C.—The Fayetteville & Wilmington Steamboat Company has been chartered in North Carolina, with a capital stock of $100,000, to operate a steamboat line, a street car system and electric light plant in Fayetteville. W. L. Holt and W. W. Morgan, of Fayetteville, are interested.

PHILADELPHIA, PA.—The Schuylkill Traction Company has authorized the creation of a new mortgage of $2,000,000 to provide for extensions to Pottsville, Tamaqua and Hazleton. These directors have been elected: Clarke Merchant, J. A. McKee, John F. Finney, H. W. Lippincott, Herman Hoopes, Spencer Cosby and Dallas Sanders.

TORONTO, ONT.—The Niagara, St. Catherines & Toronto Railway Company, which operates an electric railway between Port Dalhousie, Ont., and Niagara Falls, N. Y., has made an offer for the purchase of the St. Catherines, Merriton & Thorold Street Railway. The figure named in the negotiations is $100,000. The road will, when acquired, be put in first-class condition.

TACOMA, WASH.—Extensive improvements are to be made on the line of the Everett Street Railway Company, and a modern electric lighting plant will be installed by the company. Contracts will be let immediately for an engine of 1400 horse-power, rolling stock and electrical apparatus. Mr. E. P. Burch, engineer of the company, has gone to Minneapolis to complete arrangements for the new work.

SAN FRANCISCO, CALIF.—The Market-Street Railway Company, San Francisco, recently closed a contract for 25,000 barrels per month of crude petroleum, the contract to run three years. The Union Iron Works will use about 100,000 barrels of fuel oil per year, and has also entered into a three-year contract for petroleum. Several other large concerns in and around San Francisco have already commenced burning oil.

NEW ALBANY, IND.—The Commercial Club of this place is reviving a project to utilize the large water power of the falls in the Ohio River. The committee, including Hon. Thos. W. Armstrong, Judge J. H. Stotsenburg, Chas. Van Dusen and Geo. E. Steinhauer, will develop a plan. It is expected to furnish power sufficient for the street railways, electric light plants and many of the factories of Louisville, New Albany and Jeffersonville.

NEW YORK, N. Y.—The business of the Metropolitan Street Railway Company throughout the winter is reported to have been very satisfactory. Not only were earnings largely beyond the expectations of officials, but as there was no trouble with snow, operating expenses were relatively small. With the opening of spring work will be resumed on the improvements designed to round out the system. The Fourth Avenue, Third Avenue and other lines will be connected up with Broadway, when electric traction is installed on the latter line.

CINCINNATI, OHIO.—The Cincinnati Traction Company proposes a radical change in the system of paying death benefits to employees. The new company asks employees to pay $1 each into a general fund for both death and accident insurance, which will aggregate about $30,000 a year. The men prefer to handle their own money. Under the rules of the fund, any member discharged from the employ of the company loses all interest in the fund. The men feel that if the company should have charge of the fund it would be used as a menace to them.

YOUNGSTOWN, OHIO.—The organization of the Youngstown & Sharon Railway & Light Company was perfected in New York recently. The directors and officers are as follows: A. M. Hyatt, H. W. Whipple, P. F. Thompson, W. A. De Vitt, George F. Penhale, Randall Montgomery, W. H. Park, H. G Hamilton, W. J. Hitchcock, C. B. Wick, George D. Wick, H. M. Garlick, G. M. McElvey, G. H. Morris, Grant Hamilton, M. A. Morris, Simon Perkins, W. L. Wallace, Alex. McDowell, M. A. Fruit, and Peter L. Kimberley. President, M. A. Hyatt; vice-president and chairman, H. W. Whipple; secretary, Leighton Calkins; treasurer, O. W. Bright.

PHILADELPHIA, PA.—Albert L. Johnson of New York, C. B. Bates of New York, Francis S. Drake and T. B. Lynch, of Philadelphia, and Robert E. Wright of Allentown, completed arrangements to apply for a franchise to 175 miles of unoccupied streets in Philadelphia. They hope to introduce three-cent fares to Philadelphia and secure the terminal for a trolley line to New York. It is reported that Mr. Johnson said it was the intention to charge 50 cents from Philadelphia to New York. There are to be no crossings at grade. In case of failure to secure a franchise Mr. Johnson said there would be a house to house canvass to arouse public sentiment to the advantage of the new line.

KENOSHA, WIS.—For a long time several attempts have been made by the Chicago-Milwaukee Electric Railway Company to obtain a franchise to pass through this city, and in each case failure has been the result. Now the City Common Council has dealt a death blow to any schemes for interurban electric railways passing through the city. The committee in charge of the amended railway ordinance recommends that the Kenosha Street Railway Company be given the use of West Main street. This action will give the Kenosha company an absolute monopoly of the streets of the city, and if the Milwaukee company desires to build through the city it will be necessary for it to purchase a right of way from the Kenosha company.

THE AUTOMOBILE.

THE AUTOMOBILE CLUB OF CINCINNATI was organized March 28 at the Business Men's Club. The board of governors is as follows: R. A. Holden, Jr., Howard S. Rogers, Dr. L. A. Colter, Max Fleishmann and T. C. Meadows. Officers will be elected later. A clubhouse and speedways for automobiles are early possibilities. The securing of good roads is one of the objects of the club.

NEW YORK STATE.—Automobiles will shortly be classed with carriages and subject to all laws enacted for horse vehicles, providing the bill which has passed the Assembly becomes a law. It probably will, according to Mr. G. F. Chamberlain, of the law committee of the Automobile Club of America. Several advantages will be gained. The highways and the park roads will thus be opened in all parts of the State to the automobile. Local legislation cannot bar them out. The automobile is barred, however, from those highways such as the Speedway and Cycle Path, set aside especially for horses or bicycles. Local legislation may not limit the automobiles to less than eight miles an hour in a city or fifteen miles in the country. Where no local laws exist the chaffeur may travel as fast as he likes.

NEW INDUSTRIAL COMPANIES.

WARRENTON, VA.—The Warrenton Electric Company has been chartered by Geo. B. Stone, president, and others, of Warrenton. The capital stock is placed at $15,000.

THE CRESCENT ELECTRICAL MANUFACTURING COMPANY, of Rochester, N. Y., has been incorporated; capital, $2,000. Directors: C. R. Elliott, A. L. W. Miller and H. W. Russell, Rochester.

THE AUTOMATIC TROLLEY CATCHER & CONTROLLER COMPANY, of Syracuse, N. Y., has been incorporated; capital, $100,000. Directors: H. D. Milloy, Buffalo; J. H. Devire and W. S. Farmer, Syracuse.

SAN FRANCISCO, CALIF.—The Rotary Corliss Engine Company was recently incorporated in San Francisco, by Charles B. Lastretto, Samuel N. Goldby, Emilio Lastretto, Grant Hammond and Thomas Flint, Jr. Capital stock, $200,000; fully subscribed.

THE WISWELL-PRITCHARD ELECTRIC MANUFACTURING COMPANY, of Niles, Ohio, has been incorporated by P. J. Pritchard, W. H. Pritchard and F. W. Stillwagon, of Niles, and Henry W. Wiswell and Charles M. Wilkins, of Warren. Capital stock, $30,000. The company will manufacture electric lamps, transformers and other electrical specialties.

THE CONSOLIDATED RAILWAY LIGHTING AND REFRIGERATING COMPANY was incorporated at Trenton, N. J., on March 21, with an authorized capital stock of $6,000,000, the incorporators being William C. Stemmerman, John H. Thompson, Jr., and Clifford W. Perkins. The company is to engage in the construction and equipment of railway cars, including heating, lighting and refrigerating apparatus. Liquid or compressed air, according to the charter, is to be used for the latter purpose.

PERSONAL.

MR. V. C. GRACE has returned to Chicago to open a Western agency for an Eastern firm.

MR. BRIGGS S. CUNNINGHAM, president of the Citizens' Bank of Cincinnati, was elected a director in the Cincinnati Gas Light & Coke Company, to succeed the late Captain George N. Stone.

MR. JAMES D. REID, the veteran telegrapher, has had a serious illness at his residence in this city, and has undergone critical operations, but is reported better. The "grand old man" is well over eighty.

MISS F. OLIPHANT WARD, the daughter of Mr. George Gray Ward, of the Commercial Cable Company, is to be married on April 16 to Lieut. H. H. Hough, U. S. N., at the Church of the Heavenly Rest, in this city.

MR. SAMUEL INSULL, president of the Chicago Edison Company, is in town, and his brother, Mr. Martin J. Insull, of the General Incandescent Arc Light Company, has also just returned from a trip to the Far West, much benefitted in health.

MR. T. A. EDISON returns this week from his holiday in Florida and resumes work at once on his new storage battery, which he hopes to exhibit next week at the conversazione of the American Institute of Electrical Engineers at Columbia University.

MR. F. J. ALLEN has been sworn in as United States Commissioner of Patents, and states that he is in no wise interested in or connected with the Bell telephone. He was at one time a stockholder and director in the Empire State Telephone Company, but sold out.

MR. H. T. NEWCOMB, chief of the division of agriculture in the United States Census, has resigned that position, and will hereafter have full charge of the news and editorial columns of the *Railway World*, with headquarters at 137 South Fifth street, Philadelphia.

MR. FRANCES RAYMOND, late Western manager of the General Incandescent Arc Light Company, has established himself as a manufacturers' agent at 48 West Jackson Boulevard, Chicago, and is selling "G. I." arc lamps, Paragon fan motors, World incandescent lamps, etc.

MR. E. H. COX, who for the past five years has been with the De la Vergne Refrigerating Company, and has secured a large amount of business, including many Government contracts, for the Hornsby-Ackroyd oil engines, has resigned his position. He can be reached by addressing P. O. Box 1699, New York City.

MR. FRANK SUTTON has secured offices in the new Atlantic Building, Wall Street, New York, where he will continue his consulting engineering practice. Although still a young man, Mr. Sutton's experience as an advisor in electrical, steam and mechanical engineering problems has been quite extensive, and his numerous friends wish him increased success in his new quarters

MR. S. F. B. MORSE, who is the general passenger traffic manager of the Southern Pacific Railroad, states that he recently saw Prof. L. H. Kenner hypnotize two men by long distance telephone, from Houston, Tex., to Beaumont, a distance of eighty-five miles. Several physicians were present. Mr. Kenner is an employee of the railroad company.

PROF. M. I. PUPIN is credited in the New York Sunday *World* with an interesting talk on Edison, whom he characterizes as "the greatest inventive genius this country has ever produced." He bestows praise on Edison's low resistance dynamo, phonograph, and quadruplex and asserts that without him there would have been no great incandescent lighting art.

MR. E. J. WESSELS, formerly well known in electrical circles and lately publisher and editor of the *Great Round World*, has sold out that excellent journal to Mr. W. C. Gates, late business manager of the *Review of Reviews*, and will take a long, well-earned rest. It is his intention to sail shortly with his family for the Continent. His personal address is East Orange, N. J.

PROF. HARRIS J. RYAN, of the electrical engineering department of Cornell University, has sustained an irreparable loss in the death of his father. On March 14 Mr. Ryan senior, who for more than twenty years was cashier of the Bank of Halifax, Pa., lost his life in defending the bank against two robbers, who have been captured and convicted of murder in the first degree. Prof. Ryan has the deep sympathy of the entire profession.

MR. A. L. SCHULTZ, formerly president and general manager of the Schultz Bridge & Iron Company, Pittsburg, Pa., has been appointed to take charge of the operating department of the American Bridge Company, covering the Pittsburg district, comprising the Keystone, Pittsburg, Schultz and Schiffler plants at Pittsburg; the Wrought Iron plant at Canton, Ohio; the new Columbus plant at Columbus, Ohio, and the Youngstown Bridge plant at Youngstown, Ohio.

MR. DAVID R. WALKER, chief of the electrical bureau of the city of Philadelphia, who has held office continuously for forty-five years, is to retire on June 1. His successor is likely to be Manager John C. Sager, who has been twenty-five years in the department. The bureau began with an annual appropriation of $6,100 and now requires $1,250,000 for all the work it has to do.

EDUCATIONAL.

THE ARMOUR INSTITUTE, Chicago, founded by the late P. D. Armour, will, it is said, in all probability soon be affiliated with the University of Chicago. It now has 1000 students and 38 professors.

MR. S. D. BENOLIEL has just completed a course of eight lectures on chemistry and electricity, which were delivered at St. Bartholomews Lyceum Hall, New York City. The course was one of a number of "Free Lectures to the People," annually arranged for by the New York City Department of Education.

Trade Notes.

THE CHICAGO, ST. PAUL & MISSOURI RAILWAY has placed a contract for 36 bridges with the American Bridge Company.

THE UNITED STATES NAVY YARD, Bremerton, Washington, was recently equipped with Cross oil filters by the Burt Manufacturing Company, of Akron, Ohio.

THE ELECTRIC APPLIANCE COMPANY, of Chicago, is carrying a full stock of swinging ball lightning arresters, so that orders can be shipped same day they are received.

THREE-WIRE TRANSFORMERS.—The core type of transformer for three-wire secondary service is the subject of a recent pamphlet issued by the General Electric Company. The transformer is illustrated in detail, and its construction concisely described.

THE AUTO ELECTRIC COMPANY, 61 Elm street, New York, announces that it has greatly improved its facilities for the manufacture of its "Light-of-Asia" lamps, and other products. It is sending out an announcement of the fact that will be of interest to the trade.

STEAM PUMPS.—The Jeanesville Iron Works Company, Jeanesville, Pa., gives some valuable working data on steam pumps in Advance Sheet No. 9, just issued. The manner adopted of listing pumps is thought to be new, and will be found very handy in selecting a size for a given work.

ELECTRICAL AND STEAM MACHINERY.—Messrs. Rossiter, MacGovern & Co., 141 Broadway, New York, carry a full line of second-hand machinery of standard make; also, second-hand steam and street railway equipment. A recent pamphlet of forty pages gives a complete list of the apparatus the firm has on hand.

MOTORS AND DYNAMOS.—The Three Rivers Electric Company, Three Rivers, Mich., in a catalogue describes its new line of dynamos and motors. It gives some interesting details of construction and also points out some new features which will be appreciated by purchasers. The machines are illustrated complete and in parts.

OIL FILTERS IN HAVANA.—The Burt Manufacturing Company, of Akron, Ohio, was recently favored with an order for two 150-gal. Cross oil filters to equip the new modern power house of the Havana Street Railway Company, Havana, Cuba. As only the best, modern machinery was selected, this is a strong endorsement in favor of this filter.

THE EDISON THREE-WIRE SYSTEM.—A recent publication of the General Electric Press is a 60-page pamphlet, thoroughly descriptive of the principles and material of the Edison three-wire system. The pamphlet forms, in fact, a complete technical treatise on the system, the value of which is enhanced from the text referring to the very latest developments of the system.

ELECTRIC MEASURING INSTRUMENTS.—Whitney improved electrical measuring instruments and accessories are described and illustrated in a new 1901 catalogue issued by Messrs. Machado & Roller, 203 Broadway, New York. The interchangeable shunt feature which has been developed in connection with

these instruments, is also described. A copy of the catalogue can be obtained by addressing the firm.

THE CHARLESTON EXPOSITION.—We have received a copy of a pamphlet giving an outline of the plans of the proposed South Carolina Interstate and West Indian Exposition, which is to be held in Charleston, S. C., from December 1, 1901, to June 1, 1902. In contains some interesting facts regarding the South and its industries. Illustrations of the various buildings, and a plan of the grounds are shown.

POWER TRANSMITTING MACHINERY.—Messrs. T. B. Wood's Sons, manufacturers of power transmitting machinery, Chambersburg, Pa., in their Catalogue No. 12, give a price list, dimensions and other information concerning their power transmitting appliances, which include shafting, couplings, pulleys, hangers, friction clutches, belt dynamos, etc. The catalogue has 160 pages and is printed in two colors, brown and black.

PROTECTIVE DEVICES.—A full line of D. & W. enclosed fuses, motor cutouts and safety devices of all kinds is carried in stock by the Central Electric Company, of Chicago, which is selling agent for all D. & W. material. These devices reduce to a minimum the danger of fire through blowing of fuses, and are a great protection to life on high tension circuits. The Central Company will send illustrated bulletins of these goods upon application.

THE H. C. ROBERTS ELECTRIC SUPPLY COMPANY, of Philadelphia, Pa., has issued its usual monthly calendar blotter, announcing thereon the fact that it has just received a carload of Emerson alternating desk and ceiling fans. Accompanying this blotter is a circular describing the Roberts fixture block, with steps to fit four different sizes of standard canopies, and also a very pretty circular describing the standard Bryant-Edison sockets.

THE EAGER ELECTRIC COMPANY, Watertown, N. Y., is the name of a new organization which has taken over the electrical business of A. C. Powell & Son. The company is equipping its factory with special machinery of the latest and most improved design. It has a modern factory building, 60 by 200 feet and thirty stories high, nearby a fine water power, which gives it exceptional facilities for the manufacture of dynamos and motors. Mr. Henry Eager is the manager of the company.

THE OLDS MOTOR WORKS, Detroit, Mich., which were destroyed by fire recently, started up in new temporary quarters on March 20. New machinery has been set up. All of the concern's automobile patterns and drawings were saved, as well as large quantities of material in the warehouses, which were not burned. This is intact for the manufacture of "Oldsmobiles." The fire was caused by leakage of natural gas. The company reports that it has now on its books orders for 334 "Oldsmobiles" and gasoline runabouts.

LUNDELL MOTORS.—We are reminded of approaching hot weather by the appearance of fan motor catalogues. The Sprague Electric Company has just issued its 1901 catalogue of Lundell fan motors, in which the different types of machines are attractively illustrated. A complete price-list is also given. The frontispiece represents what is said to be "the real North pole." It shows a Lundell fan motor surrounded by icebergs, and ice everywhere, blowing the frigid air down to the Southern latitudes. Behind it the aurora borealis bursts forth in all its glory.

THE AMERICAN ELECTRICAL HEATER COMPANY, 195 River Street, Detroit, Mich., manufacturer of electrical heating devices, has just issued a new catalogue and price list which it will send without cost on application to any one who is interested in the subject of electric heating. The general use of electrically heated apparatus during the summer months is a subject that deserves more attention than it has yet received. Such apparatus answers admirably the conditions of the hot weather, owing to its concentration of form, and the fact that it inflicts the minimum of discomfort on those who have to use it.

THE STANLEY ELECTRIC MANUFACTURING COMPANY, of Pittsfield, Mass., has issued two new bulletins. Bulletin No. 114 illustrates and describes the S. K. C. frequency changer, a single machine accomplishing exactly what its name implies. In addition to altering the periodicity, it can be arranged to deliver current of a different phase relation and voltage from that which is supplied. This machine is described and illustrated elsewhere in this issue. Bulletin No. 115 contains diagrams and a description of high voltage testing sets, arranged for pressures up to 120,000 volts. Either or both of these bulletins are at the disposal of those interested and will be mailed upon request.

CORLISS ENGINES.—The Vilter Manufacturing Company, Milwaukee, Wis., has closed contracts for Corliss engines as follows: Moore-Cortes Canal Company, Wharton, Tex., one 14x28x42 tandem compound; Hunter Canal Company, Milton, La., one 17x34x48 tandem compound; J. P. Suberville, New Iberia, La., three 15x36; Thieme & Wagner Brewing Company, Lafayette, Ind., One 12x30; Plymouth Refrigerating Water, Light & Power Company, Plymouth, Wis., one 12x30; Saladin Pneumatic Malting Construction Company, Chicago, Ill., one 16x36; Standard Manufacturing Company, Appleton, Wis., one 14x30; Wisconsin Foundry & Steel Works, Cedar Grove, Wis., one 12x30; Mount Airy, N. C., one 14x36; Dorschel, Schultz & Co., Lumber, Chilton, Wis., one 12x30; Wm. Jacobs, South Bethlehem, Pa., one 10x30; Columbia Malting Company, Chicago, Ill., one 24x42.

TELEPHONE SWITCHBOARDS.—In an artistic 24-page pamphlet just issued by the Kellogg Switchboard & Supply Company, of Chicago, Ill., considerable information is given concerning the company's line of small switchboards, particularly the "Express" switchboard. It is interesting to note in this connection that the Kellogg company is building some very large exchanges. It states that it has already built two switchboards, either one of which is larger than any other switchboard in this country, and one of which is the largest in the world. The pamphlet contains some very excellent illustrations of the "Express" switchboard, giving different views of the same, also of its combined drops and jacks, ringing and listening keys, clearing-out drops, etc. The detailed views are very clearly executed, and are excellent examples of the engraver's art. At the back of the pamphlet are given some illustrations of desk pattern switchboards.

THE NEW "GENERAL CIRCULAR" issued by the International Correspondence Schools, Scranton, Pa., is a forty-eight page pamphlet describing briefly each of the courses of instruction offered by the schools. Portraits of the professors, views of the schools' handsome buildings, and other illustrations, add interest to the circular, while the earnest letters from students who have secured better positions as a result of their studies testify to the successful methods employed by the schools in teaching by mail. The number of students enrolled in the International Schools is about double the number attending all the colleges in the United States. The schools receive from their students over 15,000 lesson papers and drawing plates every week, which are immediately corrected and returned by mail, many of them going to the most remote parts of the world. Considerably more than $1,000 a week is spent for postage.

THE STUART-HOWLAND COMPANY, Boston, had ample cause for celebrating its first birthday; which event occurred on April 2, for in the one year of its life it has risen from nothing to one of the largest supply businesses in New England. The phenomenally rapid growth which this fact indicates has not been confined to any one department of the business, but has been general throughout all lines—lighting, railway, telephone and telegraph supplies—a fair indication of the magnitude of the transactions handled is the statement that the Stuart-Howland Company has on its books to-day unfilled orders for the overhead equipment of over 275 miles of electric railway on eleven different lines. From the beginning the employees of this house have been experienced and capable, and have included some of the most widly known men in the supply business. The growth of the business has necessarily increased the working force extensively, and among the more recent additions are Mr. Bruce Wetmore, to the store force, and Mr. Huntington Lee, to the force on the road. The house is to be congratulated on the large measure of success that has filled its first year of life, and is to be commended for the energy and capacity that has made this success possible.

THE MICA INSULATOR COMPANY reports gratifying increase in the demand for its patented specialties in mica and micanite insulation. Quite recently it was compelled to enlarge its factory in order to meet this increased demand, and it now has under consideration a further enlargement of its works in order to handle the extra volume of business. Its material was recognized at the Paris Exposition as a standard for electrical insulation, and was given a gold medal. It has completed quite recently several specified forms of insulation, which were used in some very novel and original installation. These forms of insulation were designed and executed by the company's engineers, who are prepared at all times to give the benefit of their experience in the insulating field to the customers of the company. A detailed description of these special forms of insulation will be given later. This company is the originator of moulded mica insulation under the trade mark of "Micanite," and has had several years of successful manufacturing to which it can point with pride. Its product is not a new one, and its workmen are thoroughly educated and experienced in the manufacture of these goods. Nothing is used in the construction of micanite but pure India or amber sheet mica, with the best shellac. No scrap mica is used. This company has offices in New York, Chicago and London, and works in Schenectady, N. Y., and Stansted, England.

Record of Electrical Patents

UNITED STATES PATENTS, ISSUED MARCH 26, 1901.

[Conducted by William A. Rosenbaum, Patent Attorney, Times Bldg., N. Y.]

670,415. ELECTRICALLY OPERATED BRAKE; G. D. Burton, Boston, Mass. App. filed April 13, 1899. Opposing solenoids are arranged to act upon a cross head, which is connected with the brake levers, so that when current is put through one solenoid the brakes will be applied and when through the other solenoid the brakes will be positively released.

670,420. RAILWAY BRAKE; A. Duppler, Jersey City, N. J. App, filed June 12, 1900. By manipulating the regular brake handle a moderate braking force is first mechanically applied, and then by a further movement an electrical brake is gradually applied.

670,425. SWITCH MECHANISM FOR SURFACE CONTACT RAILWAYS; G. T. Hanchett, Hackensack, N. J., and J. M. Murphy, Torrington, Conn. App. filed July 27, 1900. Besides improvement in the general construction of the switch box, the switch magnets are provided with two windings, so related that momentary breaks of the current caused by chattering of the contact shoe, will not permit of the releasing of the armature and opening of the circuit.

670,454. COMMUTATOR; G. W. Nistle, Chicago, Ill. App. filed January 29, 1901. To hold the segments in place upon a slate disk; the disk is perforated by holes running at right angles to each other, one of which passes through the segment and intersects the other; a screw passes through the segment and engages with a metallic body at the intersection of the two holes.

670,463. ALARM ATTACHMENT FOR DRIP PANS; L. Wahl and G. Keyes, Brooklyn, N. Y. App. filed January 21, 1901. A float carrying a circuit closer is arranged to be supported by a bracket attached to the edge of the pan.

670,474. STORAGE BATTERY; J. B. Entz, Philadelphia, Pa. App. filed July 9, 1900. A laminated combined separator and support provided internally with a series of openings constituting wells and externally upon its faces with a series of projections.

670,475. STORAGE BATTERY; J. B. Entz, Philadelphia, Pa. App. filed July 9, 1900. A combined separator and support consisting of a fluted sheet of non-conducting material, having its alternate flutes perforated and its intermediate flutes imperforate.

670,476. ELECTRICAL DISTRIBUTION. J. B. Entz, Philadelphia, Pa. App. filed September 1, 1900. (See Current News and Notes.)

670,510. PROCESS OF PRINTING AND PRODUCT THEREOF; W. Friese-Greene, London, England. App. filed June 18, 1898. (See Current News and Notes.)

670,538. SUBSCRIBER'S TELEPHONE CIRCUIT; W. W. Dean. Chicago, Ill. App. filed April 28, 1899. The microphone is in circuit with four primaries, located in the respective branches of a Wheatstone bridge, the secondaries being connected to the line, which thereby receives the added effect of all the primaries.

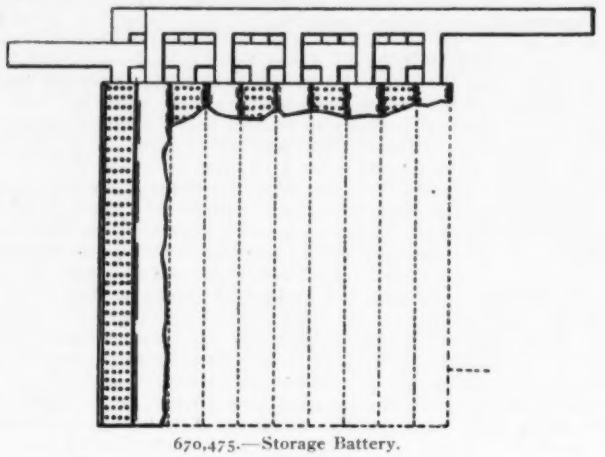
670,547. ELECTRICAL CONNECTING DEVICE; J. S. Schenck, Brooklyn, N. Y. App. filed January 20, 1900. Details of a fuse block.

670,556. ROCKER ARM; A. Cowperthwait, Brooklyn, N. Y. App. filed February 4, 1901. The rocker arm is provided with a channel in which the cross connecting conductors are lodged.

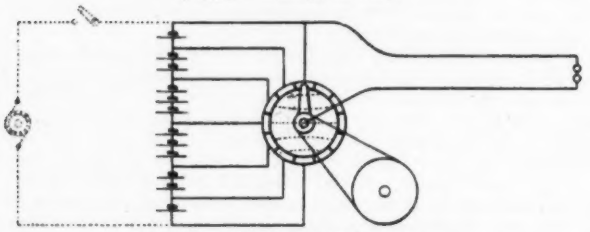
670,557. CONTINUOUS CURRENT MACHINE AND APPARATUS; M. Deri, Vienna, Austria-Hungary. App. filed March 24, 1900. (See Current News and Notes.)

670,564. TELEPHONE RECEIVER; C. H. North, Cleveland, Ohio. App. filed September 27, 1899. A construction intended to minimize the disadvantages resulting from the different rates of expansion of the material comprising the receiver.

670,573. SUSPENSION CUT OUT; J. J. Wood, Fort Wayne, Ind. App. filed



670,475.—Storage Battery.



670,697.—System of Telegraphy.

December 19, 1899. Details of a suspension cut out upon which the lamp is supported.

670,583. PRIMARY ELECTRIC BATTERY; J. P. Fontaine, Paris, France. App. filed January 9, 1900. A double fluid battery having active elements consisting of zinc and of soda lye on the one hand, and nitric acid on the other hand in combination with a porous vessel of cardboard and fabric placed together, and having a rigid internal substance permeable by the acid solution.

670,634. ELECTRIC CLOCK; F. L. Gregory, Chicago, Ill. App. filed March 2, 1900. Details.

670,648. ELEMENT FOR SECONDARY BATTERIES; J. T. Storey, Philadelphia, Pa. App. filed June 25, 1900. The plate consists of a tape wound upon itself and supported in a suitable frame.

670,651. ELECTRIC RAILWAY; W. T. Van Dorn, Chicago, Ill. App. filed April 27, 1900. A third rail is supported by brackets above the roadbed and shielded above and on the side by a hood; the collector is a spring-pressed shoe carried on the end of a rigid arm extending from the truck.

670,658. ELECTRIC ARC LAMP; E. A. Beck, Los Angeles, Cal. App. filed May 7, 1900. Details of the gas check.

670,667. ELECTRIC HEATER; W. S. Hadaway, Jr., New York, N. Y. App. filed September 24, 1898. In a heater for sad irons, the heating resistance is compressed into a chamber between two electrodes, which are adjustable with respect to each other.

670,669. ELECTRIC STOVE; W. S. Hadaway, Jr., New York, N. Y. App. filed February 1, 1899. The stove is adapted for heating flat irons, and the heating surfaces are shaped to fit the irons.

670,670. ELECTRIC STOVE; W. S. Hadaway, Jr., East Orange, N. J. App. filed June 30, 1900. A heater having two sections with active surfaces in substantially the same place, one surrounding the other, means for heating the central section by electric current and means for producing a lower degree of heat in the outer section.

670,671. ELECTRICAL HEATING RESISTANCE AND METHOD OF MAKING SAME; William S. Hadaway, Jr., East Orange, N. J. App. filed September 24, 1898. (See Current News and Notes.)

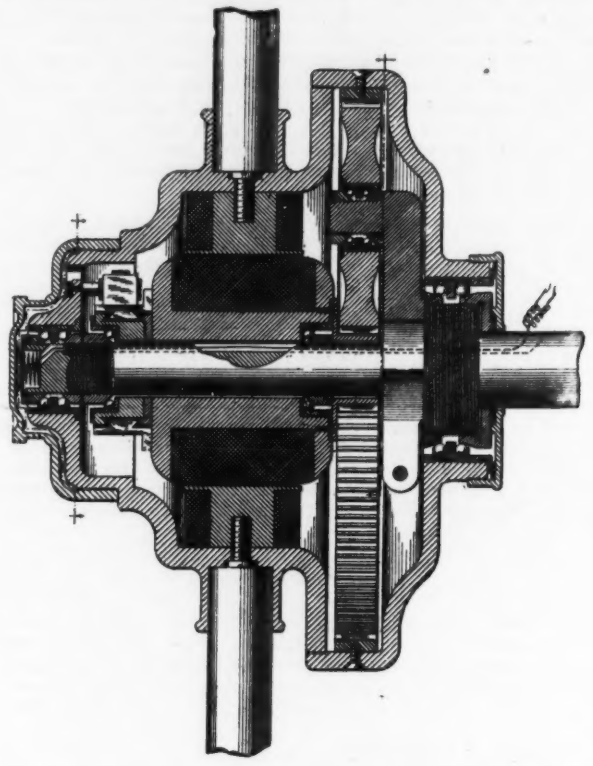
670,697. SYSTEM OF TELEGRAPHY; F. Bedell, Ithaca, N. Y. App. filed October 20, 1899. In this system there is provided any desirable sources of direct electromotive force, from which are derived a series of direct current impulses, gradually rising from and falling to zero by including and excluding in any desired order the several sources of electromotive force, so that the circuit may be closed, opened, short-circuited or grounded at the zero point between successive impulses, thereby avoiding the undesirable reactive effects from the line or table which would accompany the sudden insertion or removal of the maximum electromotive force.

670,711. COHERER FOR DETECTING ELECTRIC WAVES; A. Koepsel, Charlottenburg, Germany. App. filed August 25, 1900. (See Current News and Notes.)

670,712. TROLLEY WHEEL; R. Kuhn, Cincinnati, Ohio. App. filed November 10, 1900. The working face of the trolley wheel is covered with a detachable layer of wire.

670,774. APPARATUS FOR FORMING ELEMENTS FOR ELECTRIC ACCUMULATORS; W. Gardiner, Chicago, Ill. App. filed April 28, 1900. The apparatus is constructed so that the current passing through the plates undergoing formation can be graduated.

670,808. METHOD OF ELECTRIC WELDING; J. C. Perry, Clinton, Mass.



11,899.—Means for Propulsion of Vehicles by Electricity.

App. filed September 15, 1899. The welding is accomplished by applying a mechanical pressure nearly equal to the crushing strength of the material to be welded and simultaneously applying a current of great volume.

670,855. SAFETY TROLLEY DEVICE; C. W. Diamond, New Orleans, La. App. filed July 18, 1900. Details of a device for releasing the tension of the spring when the trolley flies upward on leaving the wire.

670,873. RAILWAY BRAKE; A. Green, Rochester, N. Y. App. filed March 1, 1901. Devices are applied to the brake controller whereby the point at which the brake goes into action, in the travel of the brake handle, can be adjusted, the object being to allow for lost motion in the parts.

670,877. PRIMARY BATTERY AND PROCESS OF REGENERATING SAME; H. K. Hess, Philadelphia, Pa. App. filed December 21, 1900. The process consists in reducing the density of a concentrated battery fluid with water, and after employing said fluid in a battery, regenerating it and vaporizing out the excess water to restore it to its original density.

670,895. UNIT MULTIPLE SYSTEM OF ELECTRICAL TRAIN CONTROL; F. C. Esmond, Brooklyn, N. Y. App. filed August 2, 1898. A variation in the wiring and connections for carrying out the well-known multiple unit system of control.

670,896. UNIT MULTIPLE SYSTEM OF ELECTRIC RAILWAYS; F. C. Esmond, Brooklyn, N. Y. App. filed August 2, 1898. A modification of the preceding.

670,897. UNIT MULTIPLE SYSTEM OF TRAIN CONTROL; F. C. Esmond, Brooklyn, N. Y. App. filed January 25, 1900. A further modification.

670,898. UNIT MULTIPLE SYSTEM OF TRAIN CONTROL; F. C. Esmond, Brooklyn, N. Y. App. filed April 10, 1900. Another modification.

11,899. (REISSUE) MEANS FOR PROPULSION OF VEHICLES BY ELECTRICITY; F. J. Newman and J. Ledwinka, Chicago, Ill. App. filed December 5, 1899. The vehicle motor is mounted in and combined directly with the driving wheel.

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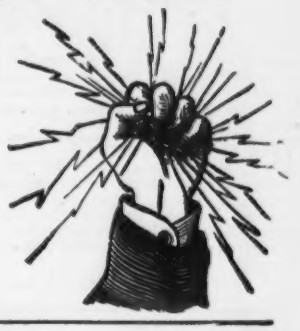

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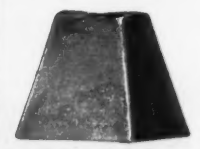
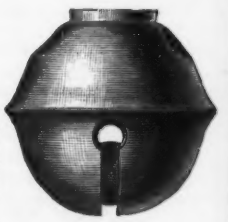
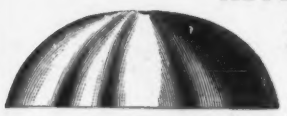

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1—25 K.W. Eddy dynamo, direct-connected to Russell engine.
2—100 K.W. Excelsior dynamos, direct connected to Russell engines.
1—80 K.W. Excelsior dynamo, direct connected to Russell engine.

500-VOLT MOTORS: Complete with pulleys, base rails, automatic release starting boxes.
1—2 H.P. Crocker-Wheeler, slow speed.
2—1 H.P. C & C.
1—10 H.P. C & C.
1—6 K.W. M.P. G.E.
2—10 H.P. M.P. Perritt slow speed.
1—15 H.P. Edison.
1—55 H.P. Ft. Wayne.
1—75 H.P. Edison.

110-VOLT DYNAMOS COMPLETE.
1—25 K.W. Eddy direct-connected to Russell engine.
2—45 K.W. Manchester Westinghouse, direct connected to Armington & Sims vertical engine.
3—60 K.W. Siemens & Halske direct-connected type.
2—12½ K.W. Kester M.P.
1—12½ K.W. Bullock M.P.
4—15 K.W. Edison bipolar.
3—20 K.W. " "
3—25 K.W. " "
4—30 K.W. " "
2—45 K.W. " "
2—100 K.W. " "
1—100 K.W. Western Electric.
1—D50 K.W. T.H.
1—50 K.W. Card M.P.

ARC DYNAMOS.

1—E6-light, 2000-cp, T.H.
1—H18-light, 1200-cp.
1—K20-light, 2000-cp.
1—M30-light, 2000-cp.
2—M45-light, 1200-cp.
2—L.D.35-light, 2000-cp.
6—L.D.2, 50-light, 2000-cp.
6—80-light, 1200 cp, Wood.

RAILWAY MOTORS.

6—Westinghouse No. 3.
30—W.P. 50's.
5—W.P. 30.
12—Johnson steel motors.
12—Equipment of G.E., 1200.
4—Equipment of Westinghouse, 38B.

CONDENSERS.

1—350 H.P. Knowles jet condenser.
1—350 H.P. Wainwright heater, with all connecting piping, valves and fittings.

ENGINES.

1—1600 H.P. Green-Wheelock.
1—1000 H.P. Fraser-Chalmers.
1—200 H.P. compound Dick & Church.
2—250 H.P. Westinghouse compound.
2—125 H.P. Taylor-Beck.
2—150 H.P. Ball automatic.
1—150 H.P. tandem compound Porter-Allen.
1—200 H.P. Russell, 4-valve automatic.

CAR TRUCKS: A full line of Brill's, Peckham's and McGuire.

LOCOMOTIVES: Full line of standard and narrow guage, freight and passenger; saddle tank, contractors' locomotives.

BOILERS.

1—150 H.P. Butmann vertical.
2—200 H.P. Morin Climax.
1—600 H.P. Babcock & Wilcox.
4—340 H.P. Babcock & Wilcox.
6—Tubular boilers, 66x16.
1—250 H.P. Cooke water tube boiler.
700 H.P. Sterling water tube boilers.
3—18x72" horizontal tubular boilers.

MOTORS AND TRAIL CARS.

4—Double-truck vestibule cars, transverse rattan seats.
9—16' Stephenson box cars, in good condition, with Peckham's trucks and Westinghouse No. 3 motors.
5—16' Stephenson cars in good running order, with G.E. 800 motors.
6—8-Bench Stephenson cars, with Westinghouse No. 3 motors, Gilbert trucks.
2—7-Bench Lewis & Fowler cars and Westinghouse No. 3 motors, Peckham trucks.
30—16' Brill car bodies.

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Large stock of Meters, Arc Lamps, Station Instruments and Supplies. All apparatus fully guaranteed in perfect operative condition. Send for Monthly Bargain Sheet with complete list and net prices.

220-VOLT MOTORS.

1 ¼ H.P. Lundell, very slow speed.
1 2 " Thomson-Houston.
1 2½ " Ft. Wayne, self-oiler, s. s.
3 3 " Sprague, self-oilers.
1 3 " Crocker-Wheeler, s. o., s. s.
2 3 " Card, slow speed, self-oilers.
1 5 " Ring type, self-oiler.
1 5 " Westinghouse, self-oiler.
1 5 " C & C.
1 5 " Akron, self-oiler.
22 5 " Gibbs, M.P., self-oilers.
1 5 " Westinghouse, s. o., M.P.
1 6 " Maher, self-oiler.
1 10 " Eickmeyer, elevator motor, with controller.
1 12 " Lundell, 10 K.W., M.P., s. o.
1 15 " Eddy, s. o., new armature.
1 15 " Edison, self-oiler, 12 K.W.
1 15 " Mather, ring type, new armt.
1 20 " Sprague.
1 25 " Siemens & Halske.
1 25 " T.-H.
1 25 " American Engine Co., M.P.
1 50 " Eddy, M.P., self-oiler.
1 50 " Northern, M.P., s. o., new.
1 60 " Edison, self-oiler.

500-VOLT MOTORS.

1 1 H.P. Jenney, s. o.
1 5 " Westinghouse, M.P., s. o.
1 7½ " Siemens & Halske, M.P.
1 10 " Card, M.P., self-oiler, s. s.
1 10 " Eddy, M.P., self-oiler, s. s.
1 10 " Westinghouse, M.P., self-oiler.
1 15 " Siemens & Halske, M.P.
1 15 " Eddy, self-oiler.
1 18 " Thomson-Houston, self-oiler.
1 18 " C & C, self-oiler.
1 20 " Commercial, self-oiler.
1 20 " Card, self-oiler.
1 30 " Commercial, self-oiler.
1 30 " General Electric, M.P.
1 40 H.P. Wood, M.P.
2 40 " Siemens & Halske, M.P.
1 60 " Edison, 45 K.W., self-oiler.
1 75 " Edison, 60 K.W.

ARC DYNAMOS.

1 20-light 2000 C.P. Western Electric.
1 30 " 1200 " T.-H., K12.
1 30 " 2000 " Brush, No. 7.
2 35 " 2000 " T.-H., L.D., 2.
1 35 " 1200 " Wood, No. 6.
3 40 " 2000 " West. Electric, s. o.
2 45 " 1200 " T.-H., M12, ball armt.
2 45 " 1200 " Brush, No. 7.
1 50 " 1200 " T.-H., L.D., 12, ball armature.
1 50 " 2000 " Brush, No. 7½.
1 50 " 2000 " T.H., M.D., 2, ring armature.
2 60 " 2000 " West. Elec., s. o.
1 60 " 2000 " Westinghouse.
3 60 " 2000 " Wood, No. 8.
1 65-light 800 C.P. Ball, 4 amp.
1 65 " 2000 " Brush, No. 8, Steubenrausch fireproof commutator.
2 75 " 1200 " Wood, with new armt.
2 75 " 1200 " Standard, self-oilers.
2 75 " 2000 " Westinghouse, s. o.
3 125 " 1200 " Excelsior, latest type.

110-VOLT INCANDESCENT DYNAMOS.

1 10-light Roth, compound.
1 35 " Mayo, slow speed.
1 50 " Hawkeye.
1 50 " Lundell, self-oiler, slow speed.
1 50 " Card, multipolar, self-oiler.
1 60 " Thomson-Houston, compound.
1 60 " Mather.
1 65 " Crocker-Wheeler, s. o.
1 80 " Sprague.
1 100 " Bain, compound, self-oiler.
1 100 " J. & C., self-oiler, newly rewound.
1 100-light Siemens & Halske, type L. H.
2 110 " Gibbs, compound, self-oilers.
1 110 " Edison.
1 135 " Gibbs, M.P., self-oiler.
1 150 " Mather, compound, self-oiler.
1 150 " Gibbs, M.P., self-oiler.
1 150 " Edison.
3 150 " Fisher, direct connected to engine.
1 160 " Card, self-oiler.
1 180 " Siemens & Halske, M.P., s. o.
1 200 " Rockford.
3 210 " Edison, self-oilers, 12 K.W.
4 210 " Siemens & Halske.
1 210 " Siemens & Halske, M.P.
2 210 " Gibbs, M.P., self-oilers, s. s.
1 225 " Detroit.
1 250 " Westinghouse, horizontal type.
1 250 " Commercial, comp., self-oiler.
1 250 " Eddy, self-oiler.
1 270 " General Electric, 15 K.W., M. P., direct connected.
1 275 " King, self-oiler, compound.
1 300 " Columbian, multipolar.
2 300 " Gibbs, M.P., self-oilers.
1 340 " Eddy, self-oiler, compound.
2 350 " Hawkeye, compound.
1 350 " National, self-oiler, compound.
1 350 " Edison, 20 K.W., shunt.
1 350 " Western Electric.
1 350 " Fisher, M. P.
1 360 " Duplex Multipolar, compound.
9 500 " Siemens & Halske, self-oilers.
4 540 " Edison, 30 K.W., compound.
1 600 " Eickmeyer.
1 700 " Westinghouse, slow speed, M. P.
2 800 " Edison, 45 K.W., self-oilers, compound.
1 1000 " Edison, 60 K.W.
1 1200 " Siemens & Halske.
1 1350 " Siemens & Halske, 80 K.W., for direct connection.
1 1500 " Siemens & Halske, 100 K.W.
1 2500 " Siemens & Halske, 150 K.W., for direct connection.

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Or Exchange

All apparatus shipped by us is in first-class condition and will give service equal to new.

QUICK DELIVERY—LOW PRICES

ALTERNATORS

1—650 K.W. Stanley (belted).
1—400 " G. E. (new).
2—300 " Stanley, direct connected to McI. & S. engines.
2—300 " Stanley (belted).
1—120 " Westinghouse.
1—120 " General Electric.
1—100 " Wood.
2— 70 " T. H.
2— 60 " General Electric.
2— 60 " Westinghouse.
1— 50 " Wood.
1— 50 " Westinghouse.
1— 45 " "
4— 35 " T. H.
3— 30 " General Electric.
1— 30 " Westinghouse.

ARC DYNAMOS.

2—160-Light No. 12 Brush, multi-circuit.
1—125 " Brush.
2—125 " Wood.
1— 60 " Wood.
3— 50 " Wood.
1— 50 " T. H.
2— 45 " Brush.
2— 35 " T. H.
1— 30 " T. H.

GENERATORS, ETC.

1—50 K.W. C. W. 110-volt, direct connected Buffalo engine.
2—25 " American Ball, 110-volt, direct connected to American Ball engines.
1—30 " G. E. 220-volt, direct connected, G. E. engine.
1—50 " Eddy, 110-volt.
3—25 " Edison, 110-volt.
1—15 H.P. Commercial Motor, 220-volt.
1—15 " Rochester Motor, 500-volt.
1— 6 " Otis Elevator Motor, 220-volt.
1— 3 " Westinghouse Alternating Motor.
1— 1 " Westinghouse Alternating Motor.

ARC LAMPS.

300—T. H. M. 12 Double Carbon.
200— " " 2 " "
150— " Improved M Double Carbon.
The above lamps are in fine condition and very cheap.

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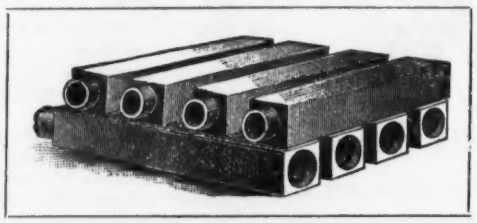

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Seven-foot lengths, 3 and 3¼-in. bore; weight, 2 lbs. to foot. Made in desired sizes from 2" to 8". Price, F. O. B. destination, cheapest of any conduit on market. Prices for high voltage conduit upon application.

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15 TO 20 PER CENT. LESS THAN TILE CONSTRUCTION

Outside diameter, 4½ inches. PATENTS PENDING. Bore, 3, 3⅜ and 3¾ inches.
Length, 6 feet.
Pipe are easily sawed to any desired length or angle.

NO INSPECTION OF PIPE REQUIRED — All Pipe are Perfect — WE STAND LOSS BY BREAKAGE

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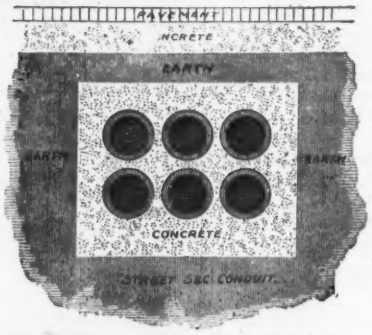

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It is the strongest of CONDUIT STRUCTURES, as the concrete unites with the exterior of the pipe.

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